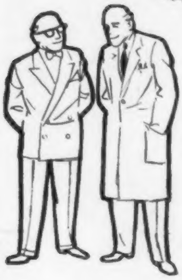
MACHINERY

JUNE 13, 1958 ONE SHILLING & THREEPENCE

"Our heat-treatment? Wild-Barfield furnaces of course"



Where heat-treatment is concerned—are you doing the job as economically as possible? It's surprising the number of people who invest in expensive machine tools—and then spoil a good job in outdated furnaces. And the result? Rejects—time, money and probably customer goodwill lost. More and more people are relying on Wild-Barfield equipment. Write for full details of the Wild-Barfield range and see how you can save by changing to modern, electric furnaces.

Horizontal General Purpose Furnace HW.I.

ELECTRIC WILD BARFIELD FURNACES

FOR ALL HEAT-TREATMENT PURPOSES

WILD-BARFIELD ELECTRIC FURNACES LIMITED

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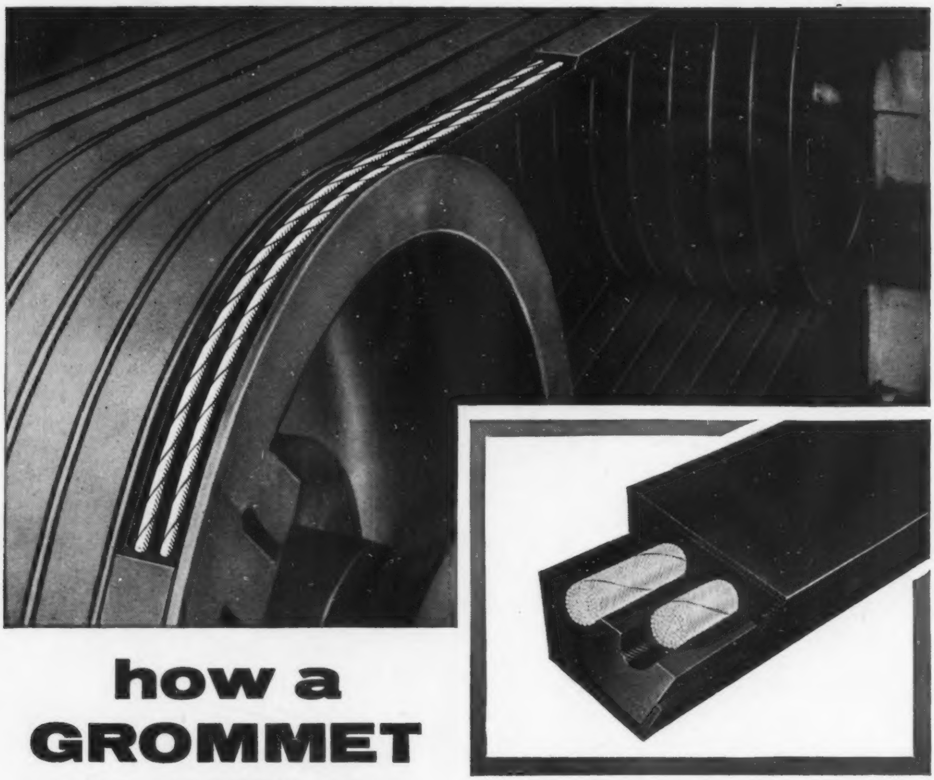

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A BTR High Test Grommet V-belt drives heavier loads with a higher safety factor because it's stronger; transmits more power for electricity consumed because it's more flexible; lasts longer because it's more durable, size for size, than any other V-belt.
'Grommetise' your drives with BTR High Test Grommet V-belts, especially where conditions are punishing—the more difficult the drive the more outstanding you'll find BTR High Test Grommet V-belt performance.

- **A grommet (a cord loop built by winding high-tensile rayon cord upon itself in an endless spiral) is essentially strong and flexible.**
- **Grommet spiral construction ensures that all the windings share the load and stresses equally.**
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- **The grommets are on the neutral axis of the belt and largely unaffected by flexing stresses as the belt travels round the pulleys.**
- **Grommet construction makes room for extra rubber to absorb shock loads and protect the grommets from unfavourable conditions.**

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Patented in Britain by BTR Patent No. 567406

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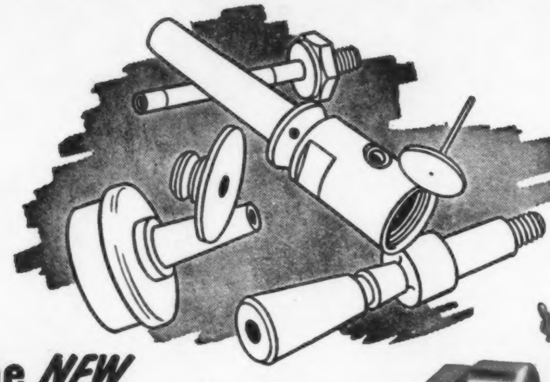
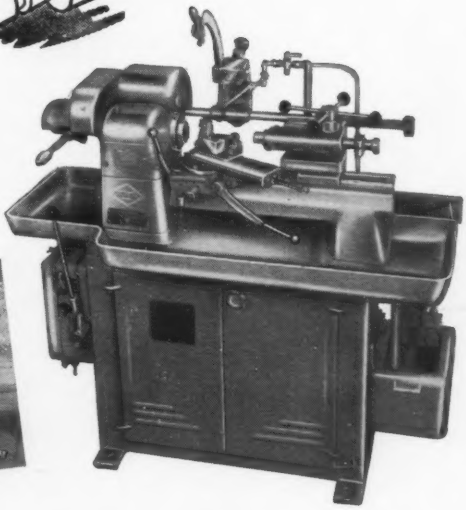
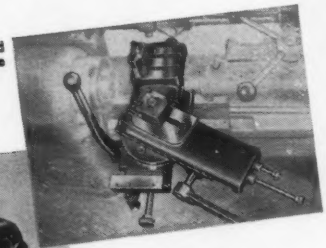


with the NEW ACCURATOOL

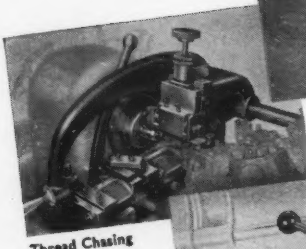
SECOND OPERATION LATHE



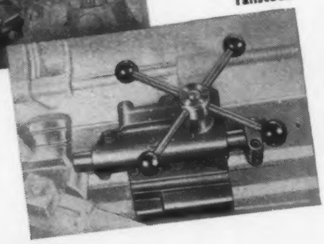
Compound Slide



Thread Chasing Attachment



Drilling and Boring Tailstock



With 4" turning length and lever operated compound slide swivelling up to 45° for taper turning, this machine is unusually sensitive and versatile. Work up to nearly 3" dia. can be handled. The collet is lever operated (air operated collet extra) and the drilling and boring tailstock is provided with drill extractor. Eight spindle speeds 75–3000 r.p.m. or alternative higher speeds are available, a single lever selecting High or Low speeds, both Forward and Reverse.

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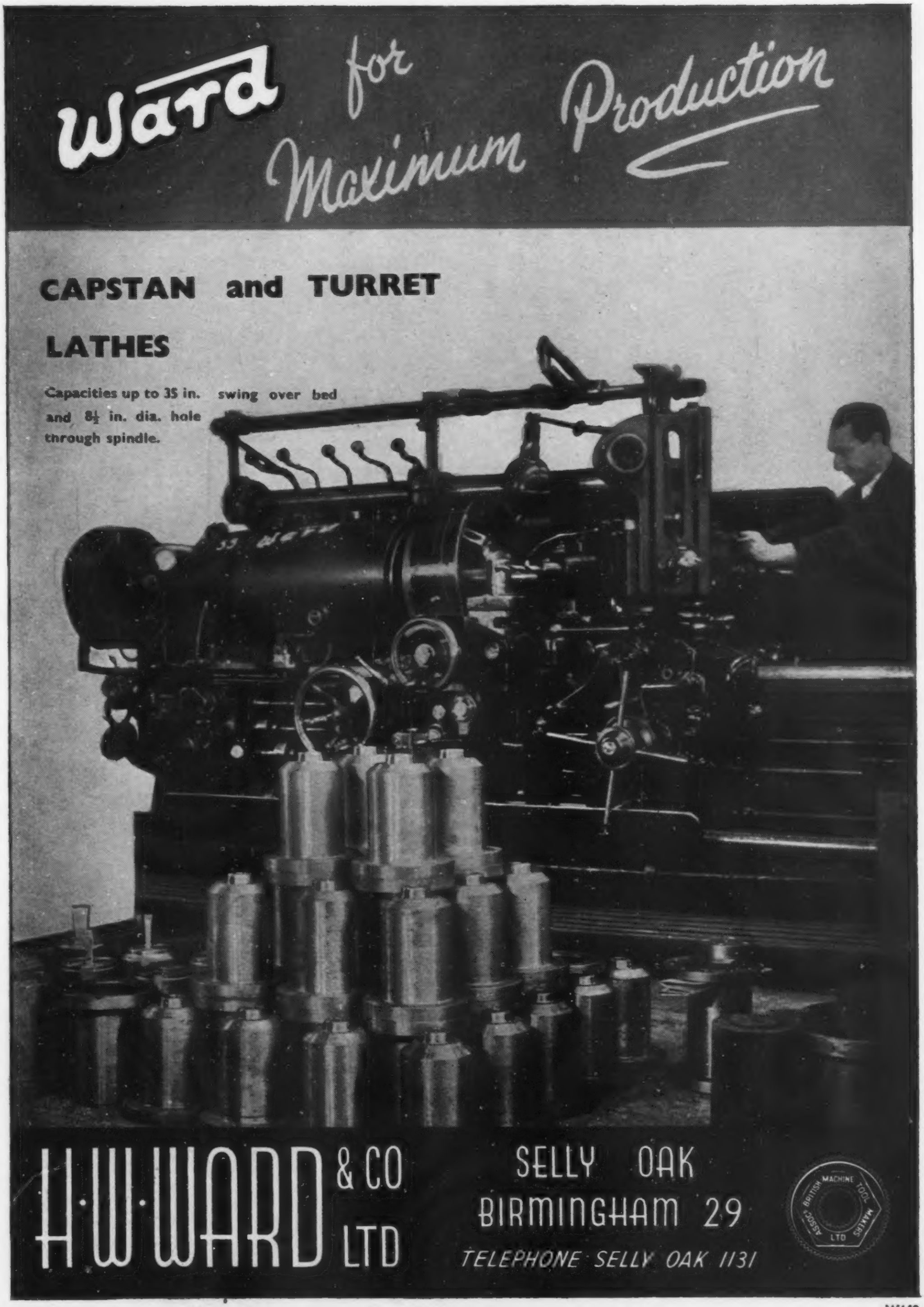
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CAPSTAN and TURRET LATHES
Capacities up to 35 in. swing over bed and 8½ in. dia. hole through spindle.
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W649

54·75" (52 min)
37·875" (32 min)
TYPICAL PROFILING FLOOR TO FLOOR TIMES
model J 6
Unitrace Profiling
Lathe
16·06" (9 min)
2·5"
(13 min)
24·625" (19 min)
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PROFILING
TURNING
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+
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SURFACING & SCREWCUTTING
LATHE ALL IN ONE MACHINE
43·25" (73 min)
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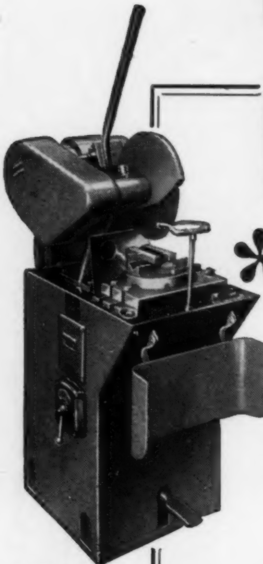
POWA-LASTIK

* PATENTS PENDING



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* **ABRASIVE WHEEL**

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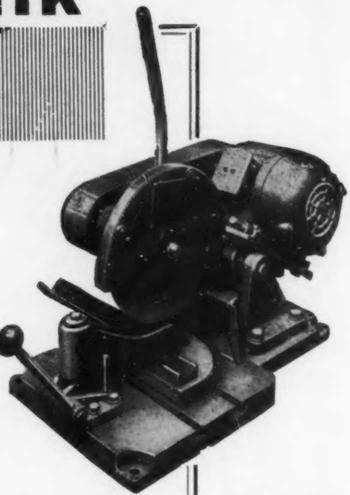
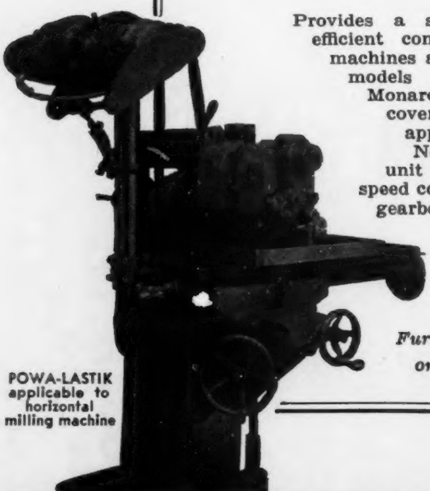


Bench Models 10" Wheel or Saw

MACHINE TOOL DRIVING UNITS

Provides a speedy, simple and efficient conversion of existing machines at low cost. Four models (Minor, Major, Monarch and Mammoth) cover a wide range of application. New gear drive unit features the four-speed constant-mesh gearbox with convenient change lever enabling quick selection of speeds.



POWA-LASTIK applicable to horizontal milling machine

Gear Drive Unit Model G.1

Further details gladly supplied on application to Dept. M.

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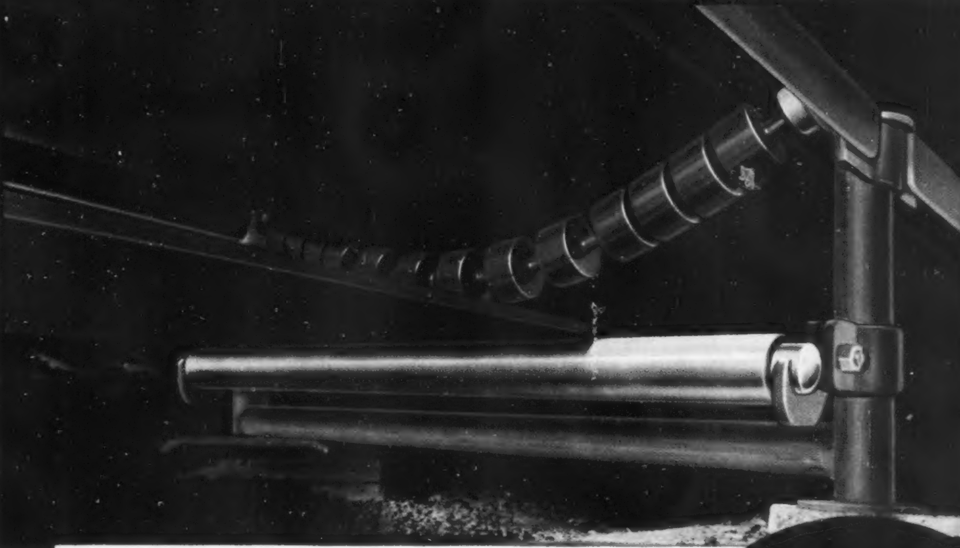

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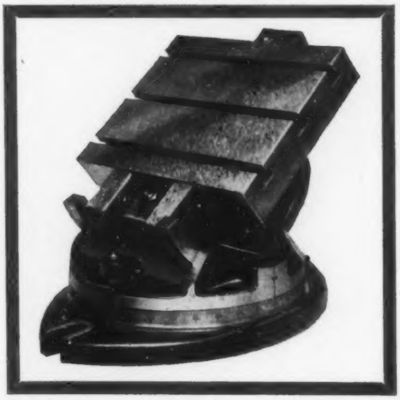
THE ABWOOD UNIVERSAL COMPOUND ANGLE TABLE



Universal table fitted with interchangeable rectangular table. Changeover from circular to rectangular table is readily effected by loosening clamping bolts.

Movements in the table are fully indexed through 360° in the horizontal plane and 90° in the vertical, so that any combination of angles may be obtained. 'T' slots in the table are machined from the solid and a hole is bored centrally and fitted with a steel sleeve for receiving spigots. Available in two sizes, circular 6in. and 8in. diameter, rectangular 8in. by 6in. and 10in. by 8in.

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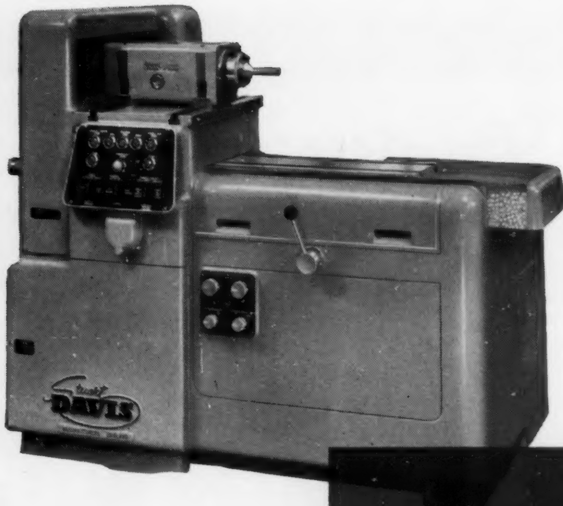

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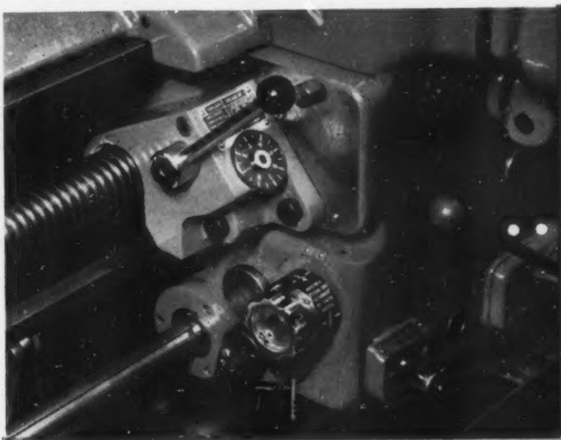

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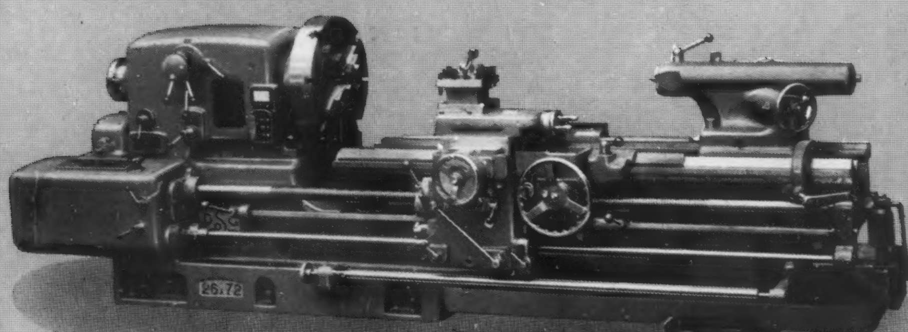
ON 26″ and 30″ SWING LATHES

Rotation of finger knob on end of apron gives 4 changes to normal feed rate from operators position

Ratios: 1½-1, 1-1, 3-4 & 1-2



DESCRIPTIVE LITERATURE SENT ON REQUEST

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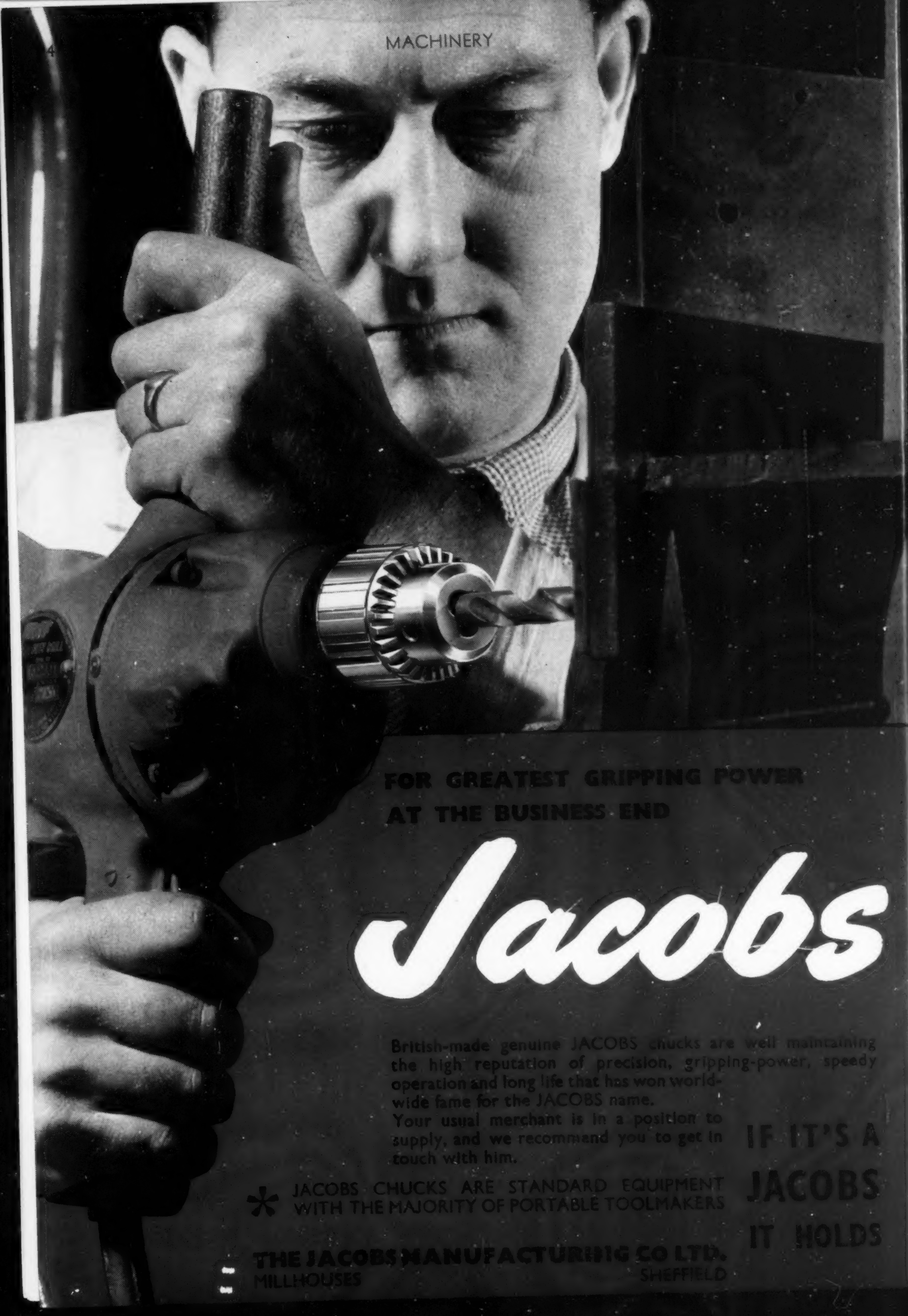
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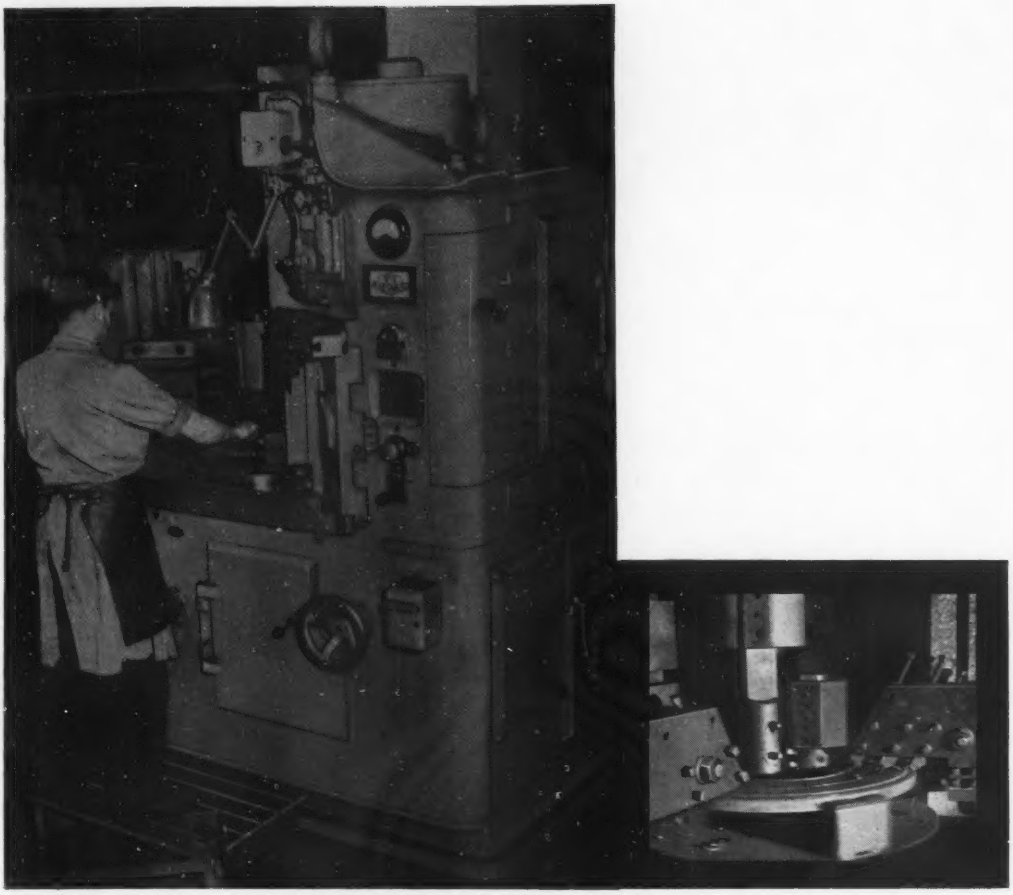

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The vertical design of Rydermatics gives rigidity, easy loading and accessible tooling; the simple tooling system allows easy changeover for a variety of work.
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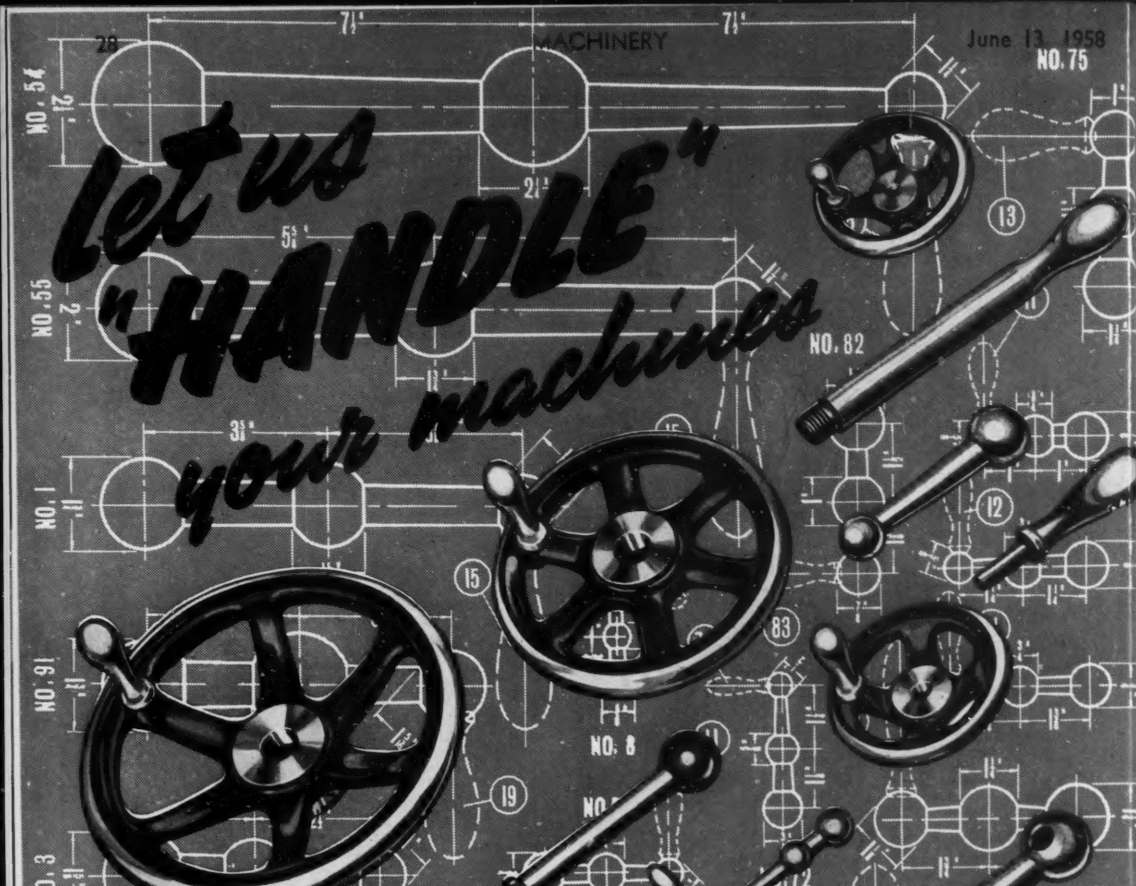
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A Multi Station Indexing Machine producing Differential Pinions of the Massey-Ferguson 35 Tractor at a production time of one set of four per 100 seconds.

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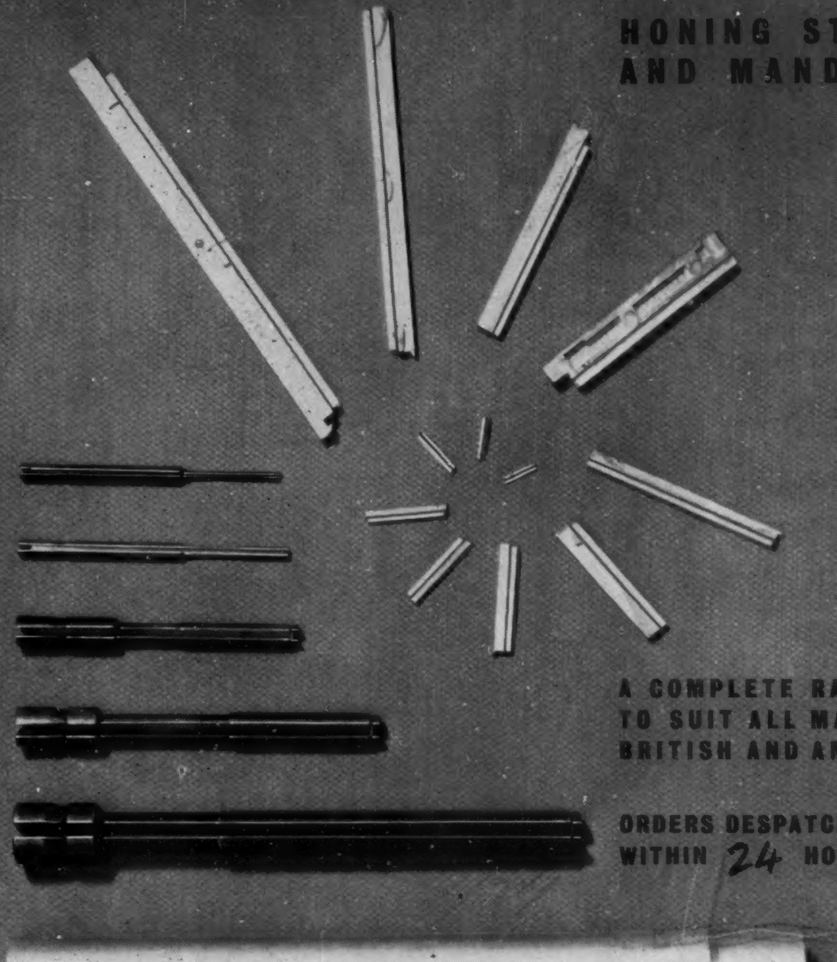

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★ SWIVELLING HEAD
★ POWER DOWN FEED TO SPINDLE
★ GAUGE BLOCK MEASURING EQUIPMENT FOR ACCURATE POSITIONING WHEN BORING
★ PRECISE · VERSATILE · ROBUST

With its wide range of movements, gauge block measuring equipment, ample power and robust construction, this machine is capable of precise and rapid production on a wide range of work.

NOTE THESE FEATURES

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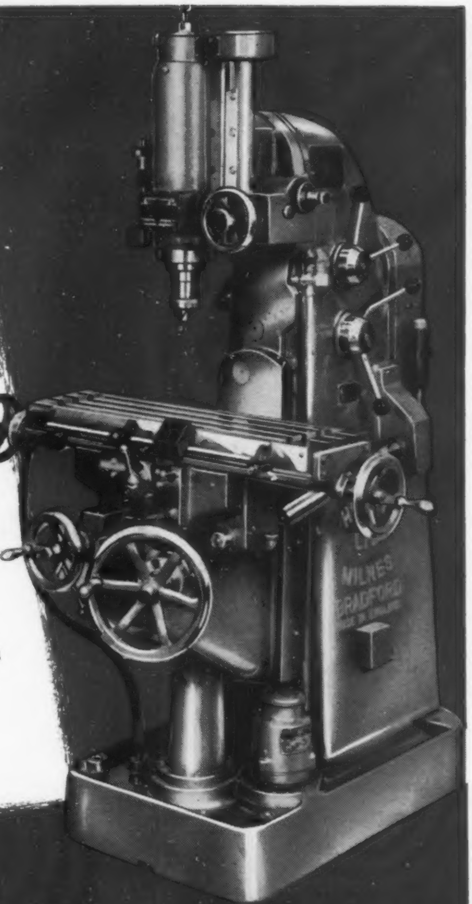
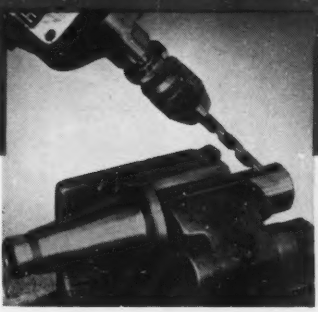
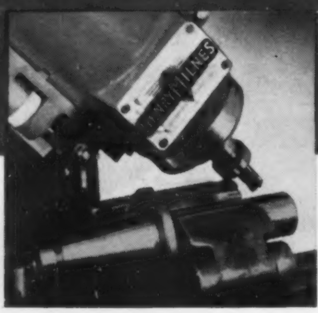
- Head with power down feed, can be swivelled through 360 deg.
- Table feed, automatic 18in.
- Cross feed 6½in., vertical 14½in., both hand.
- Spindle to table 15in.
- Spindle speeds 50 to 1,000 r.p.m.
- Table working surface 30in. by 8½in.



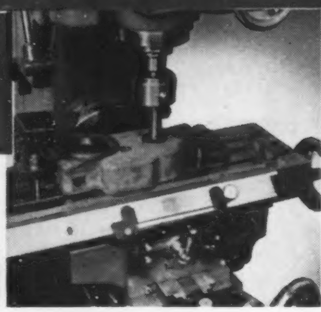
EARLY DELIVERY



ANGULAR DRILLING



ANGULAR END MILLING



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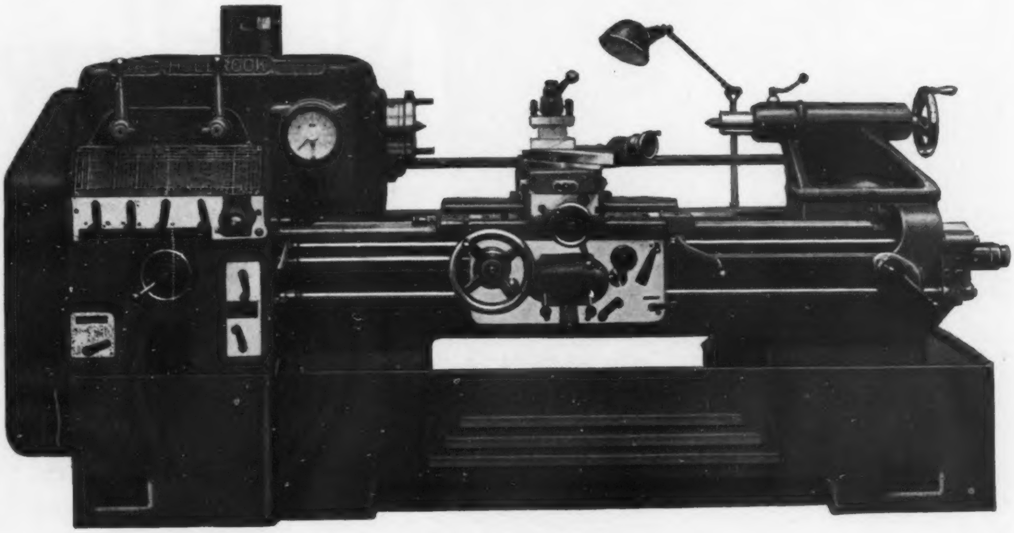

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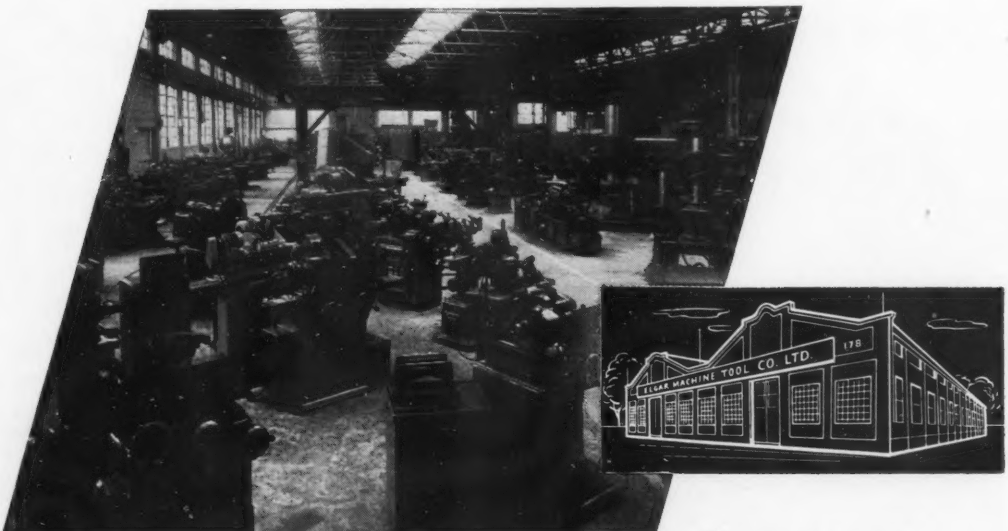

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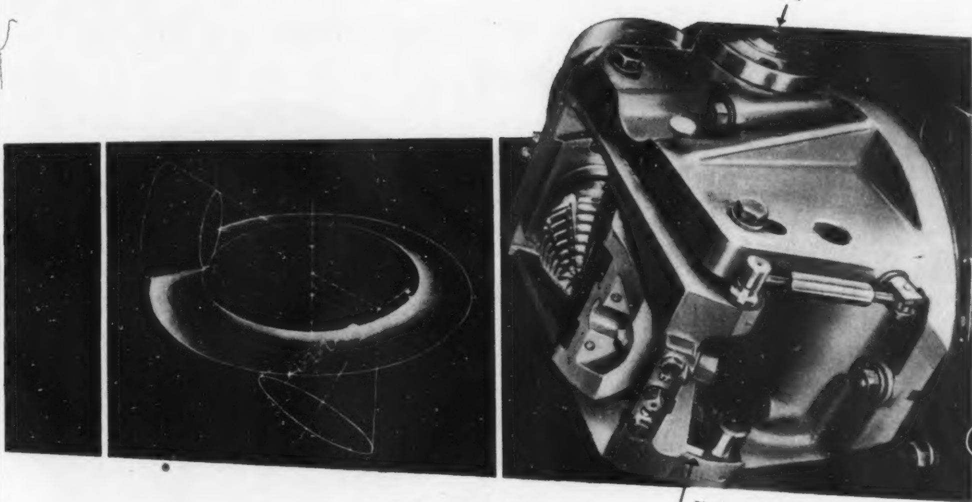
Adjustable hobbing head can be swivelled round this axis.



Block gauge for setting the length of area of contact.

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(used in all industries, and especially in the manufacture of transport vehicles.)

The Klingelnberg method is the only one producing spiral bevel gears by the use **of hobs.**

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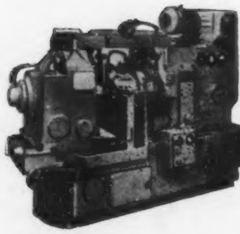

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Of this precision dividing-head plate for milling machines Cunliffe & Croom say, "We find that by using Harper Castings we get a plate with a good clean surface and, equally important, consistent hardness. Each casting has to be drilled with about 2,000 small holes which must have a clean edge and a firm wall between the holes which are extremely close together."

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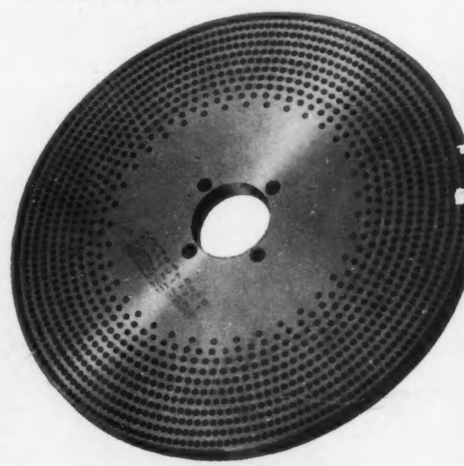
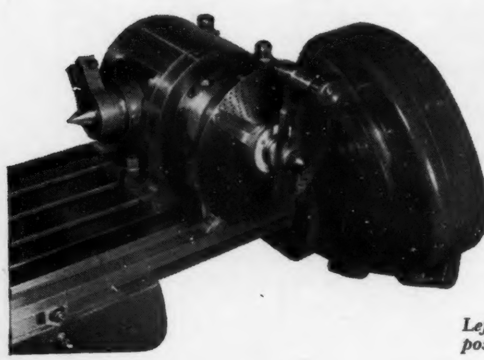


Casting machined and drilled.



Left: Finished Casting in position on milling machine.

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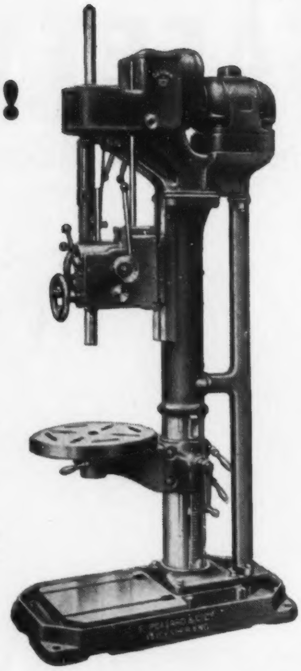
Do the 'hole' job better !



Model 21AR

Light Duty Vertical Round Column . Machine $1\frac{1}{4}$in. Cap in M.S.

Model 28AN

Heavy Duty Vertical Box Column Machine 2in. Cap in M.S.

Made in 3 sizes
$1\frac{1}{4}$in., $1\frac{1}{2}$in., 2in. capacity

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Box column machines supplied in multiple form

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9 spindle speeds

Automatic feed:
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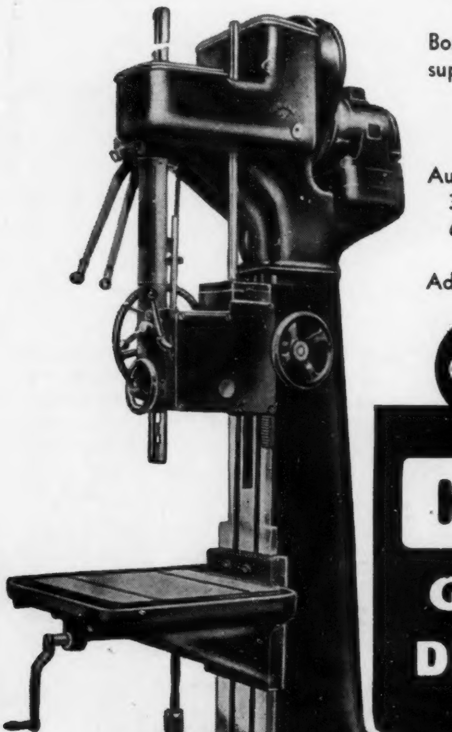
6 rates—heavy model

Adjustable head and table



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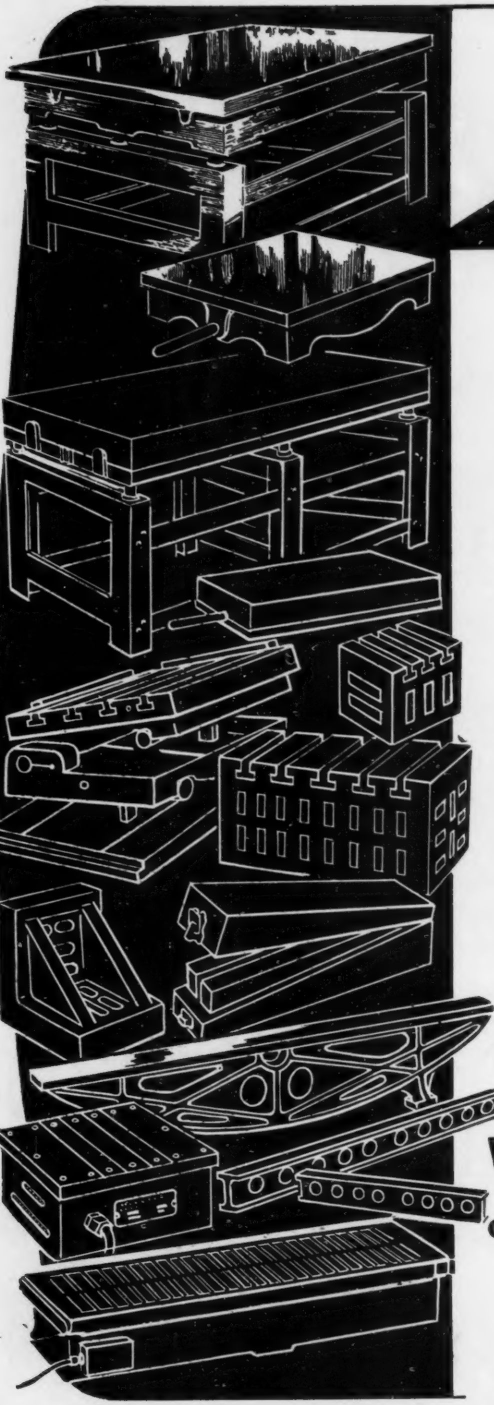
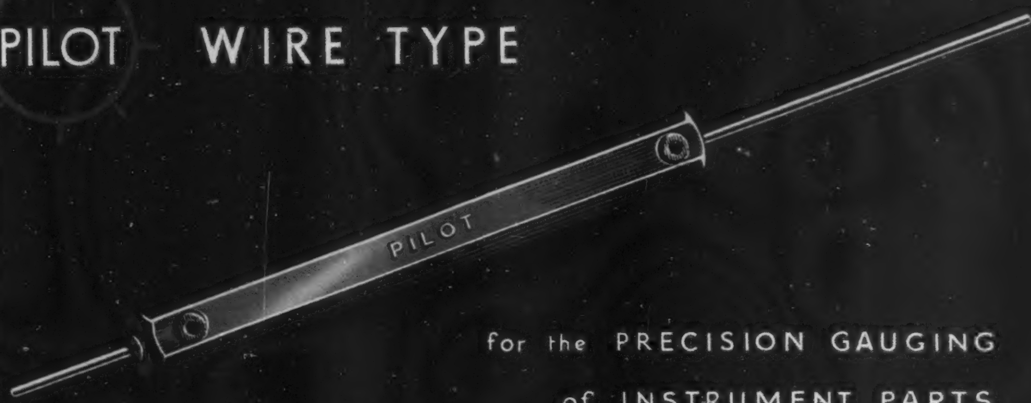


PILOT WIRE TYPE



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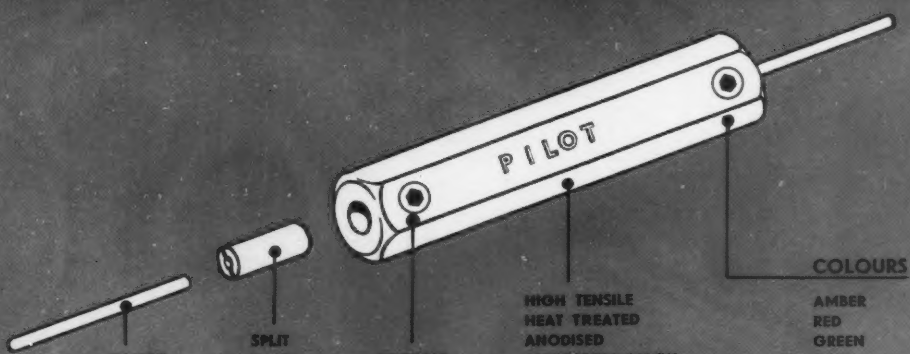

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.000" – .010"		45/-		20/-
.011" – .020"		40/-		18/-
.021" – .250"	45/-	35/-	20/-	15/-
.250" – .500"	57/-	43/-	26/-	19/-

The lengths of the gauge ends vary with diameter and are from 1¼in. to 1¾in. long. Because they are parallel' the worn front end in the smaller sizes may be cut off and the gauging member ed a little further out of the handle.

Alternatively it can be turned end for end.

PILOT holds at least 50,000 of these high precision gauges in stock for immediate delivery when required.

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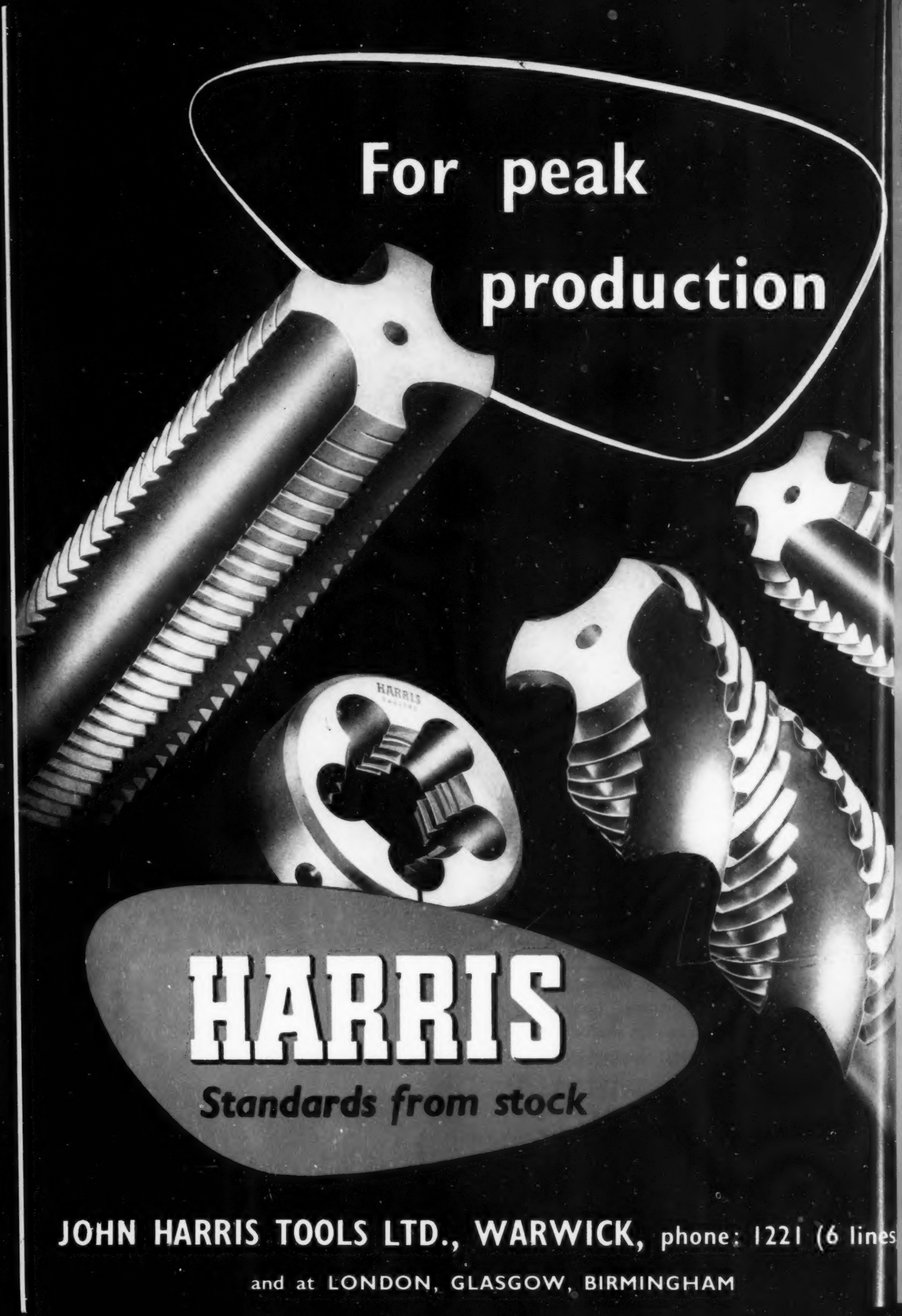
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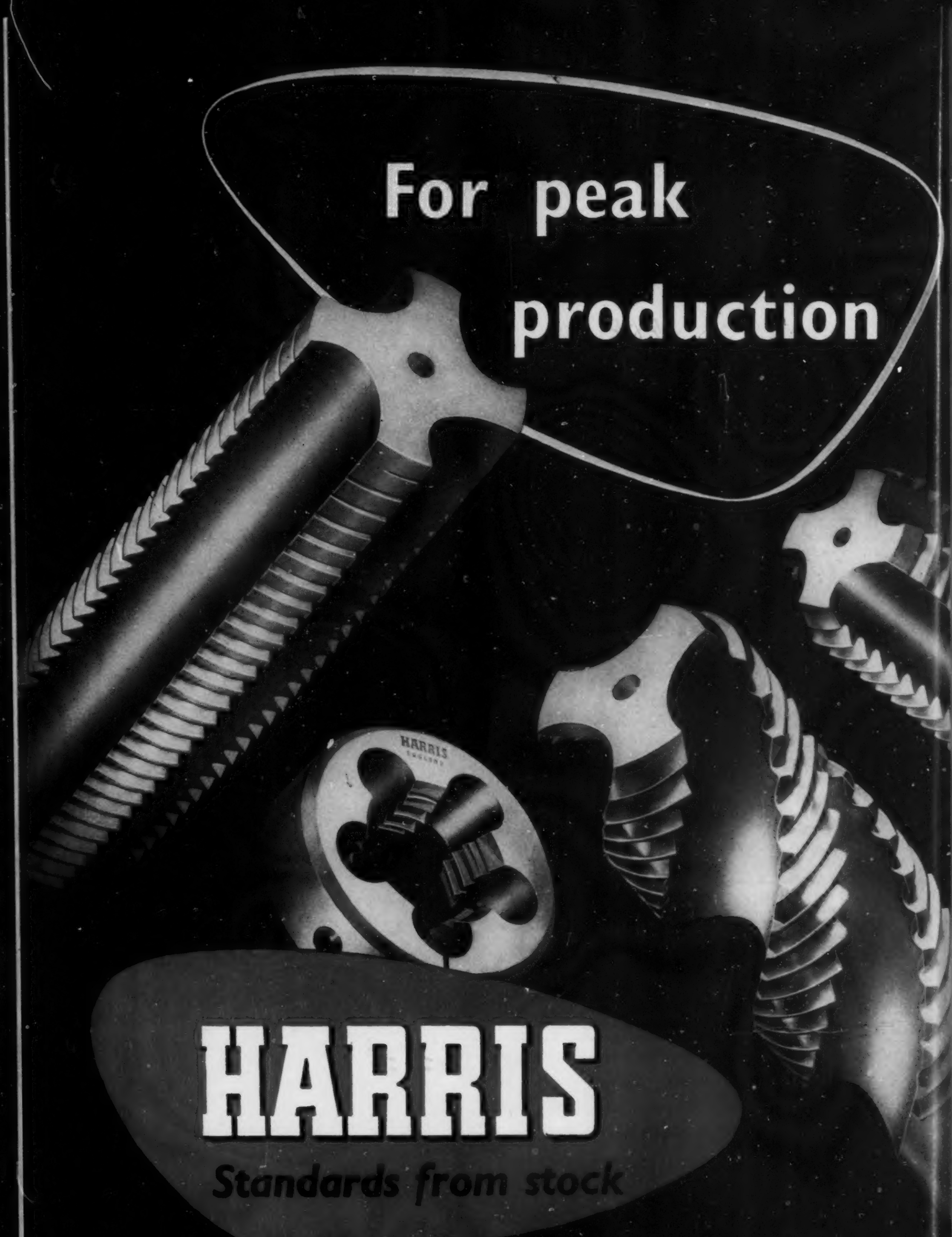
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means added value

MODEL A 4½"

SCREWCUTTING LATHE

16 spindle speeds make this precision lathe ideally suitable for toolrooms, workshops, light manufacturing and for apprentice training schools. Versatility is further increased by the wide range of accessories available. An unbeatable machine at

£185

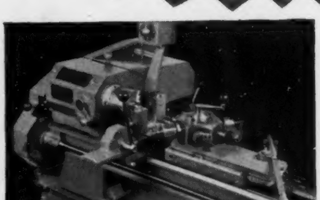
SPECIFICATION

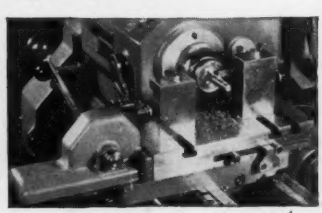
Height of centres ... ... **4½"**
Between centres ... ... **22" or 28"**
Range of speeds ... **40-1300 r.p.m.**

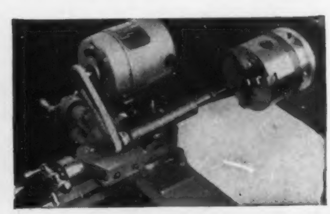
"KNOW YOUR LATHE"

A comprehensive training manual on all aspects of lathe operation. 115 fully illustrated pages packed with information for 6s. 6d.

LEFT. Six station turret head for bed mounting.
CENTRE. Cut-off slide for use in conjunction with turret head.
RIGHT. Tool Post Grinder.







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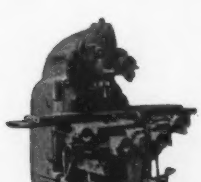
Electromagnetic Multiple-Plate Clutches

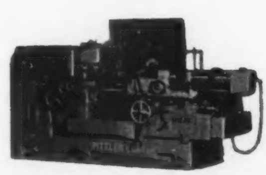
The sound design and outstanding efficiency of our electro-magnetic multi-plate clutches has ensured their wide adoption for machine drives of every type.

Multiple thin magnetic steel plates form an exceptionally compact unit, capable of transmitting very high torques. Operation is unaffected by oil and the clutches are therefore very suitable for gear box operation. No adjustment is necessary, as the clutches will function without an air gap.

TYPICAL APPLICATIONS OF OUR ELECTRO-MAGNETIC MULTI-PLATE CLUTCHES



VERTICAL MILLING MACHINE
The feeds, either forward, rapid traverse or rapid reverse, are charged by means of electro-magnetic multi-plate clutches.



TURRET LATHE
On which spindle speed changes are made through electro-magnetic multi-plate clutches.

VERTICAL TURNING AND BORING MILL
On which the electro-magnetic multi-plate clutch ensures gentle, but firm braking.

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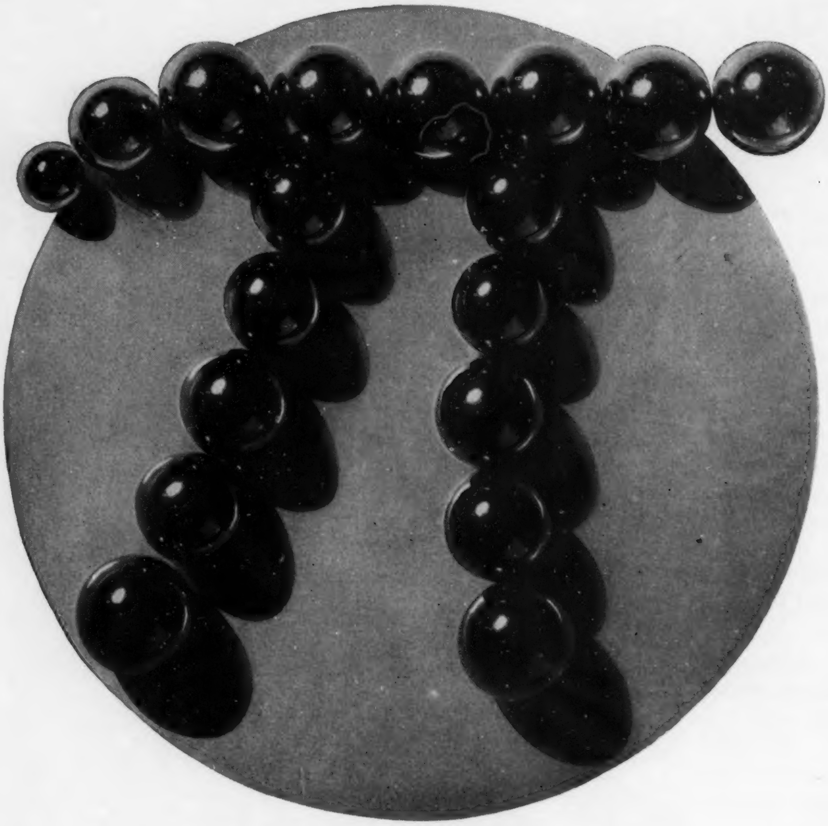

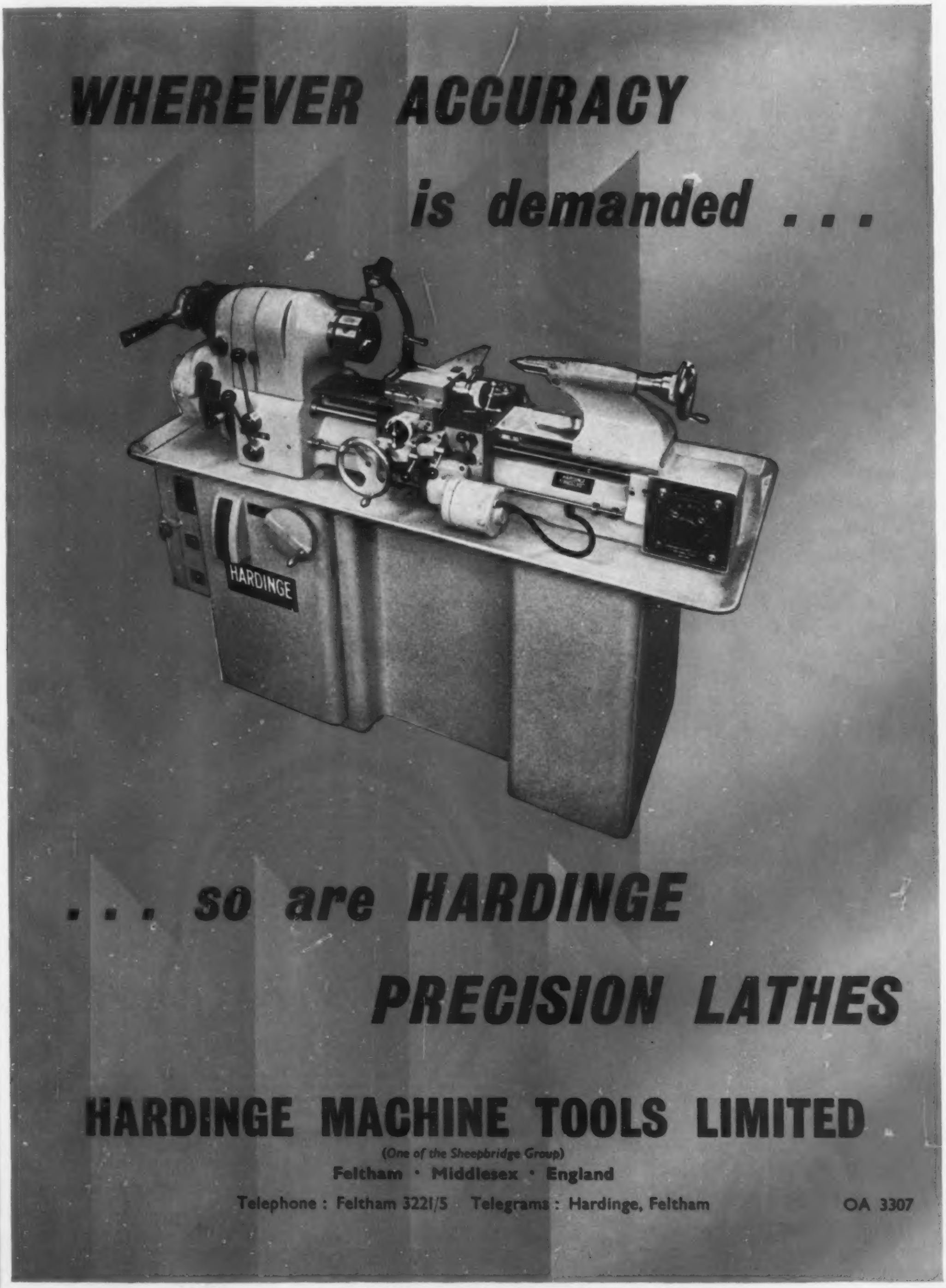
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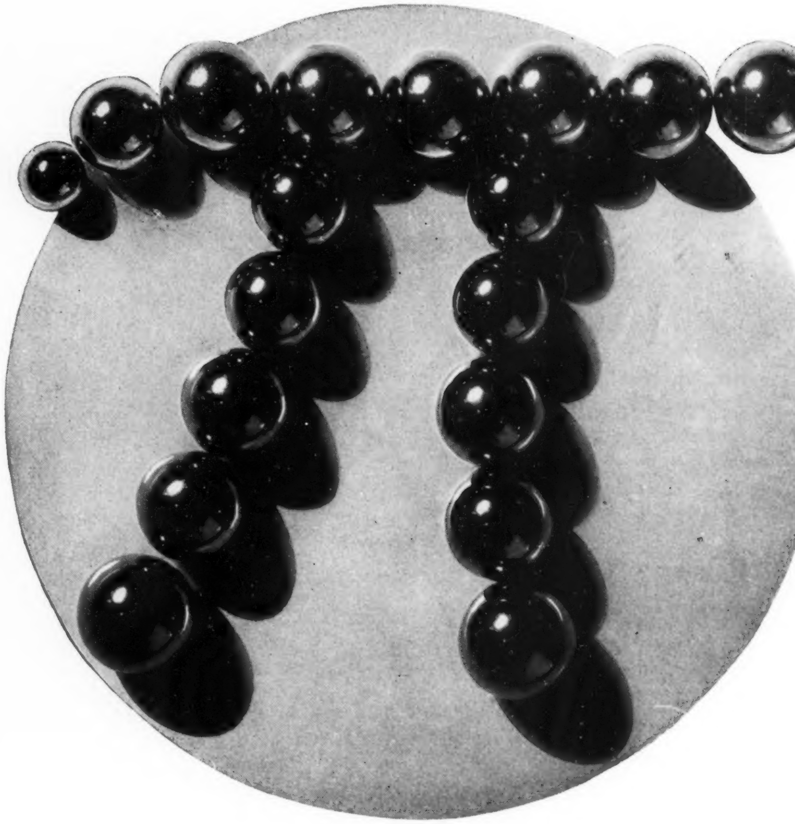

THE π BALL

π, we understand from those who know, may be approximated to ten or more places of decimals, viz., 3.1415926536. Hoffmann balls are not guaranteed to be quite so near to absoluteness as that, but they are guaranteed to be within 1/10,000" both as to size and sphericity; and what is more important, the variation between any two balls in a bearing is far finer. And what of surface finish? Hoffmann balls are of incomparably flawless mirror finish. There is nothing piebald about the π ball!

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THE LOAD CARRIERS OF THE WORLD-FAMED HOFFMANN BALL BEARINGS

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A 'MUST' for every Toolroom

THIEL 158

for the manufacture of

FIXTURES • JIGS
PUNCHES
GAUGES • DIES

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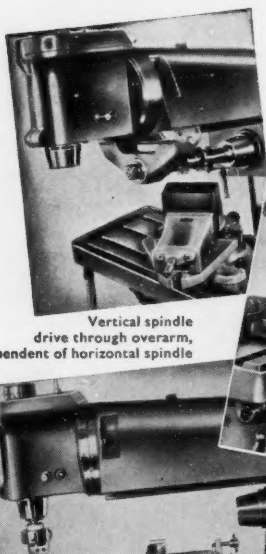
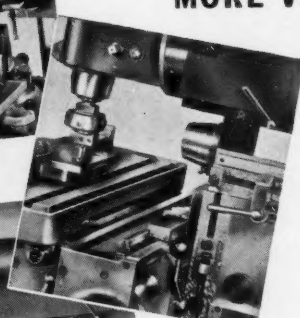
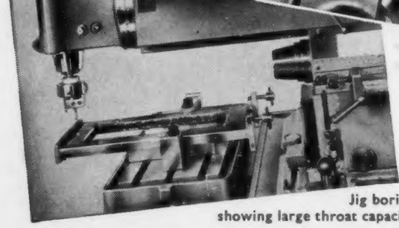


Vertical spindle drive through overarm, independent of horizontal spindle



Close to column jig boring



Jig boring showing large throat capacity

MORE VERSATILE

HIGHER PRECISION

EASIER TO OPERATE

This Thiel has a higher value in the tool room than any other single piece of equipment for the manufacture of punches, dies, gauges, profiles, jigs and fixtures. Most other equipment of the older No. 58 will fit this machine.

Large number of attachments can be supplied including drilling attachment with spindle speeds up to 5000 r.p.m. All power feeds fitted with automatic stops and fine measuring device.

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THIEL 158

for the manufacture of

FIXTURES · JIGS
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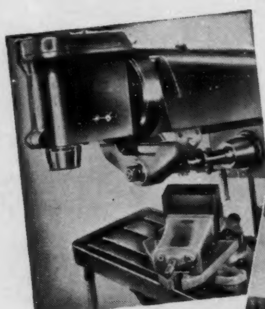
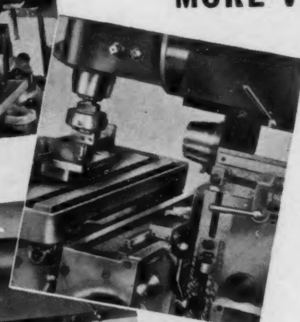
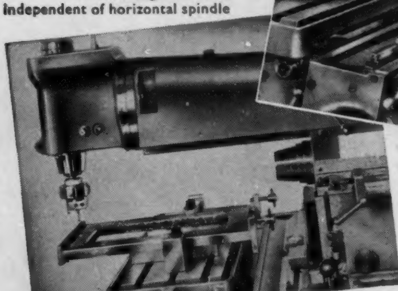


Vertical spindle drive through overarm, independent of horizontal spindle



Close to column jig boring



Jig boring showing large throat capacity

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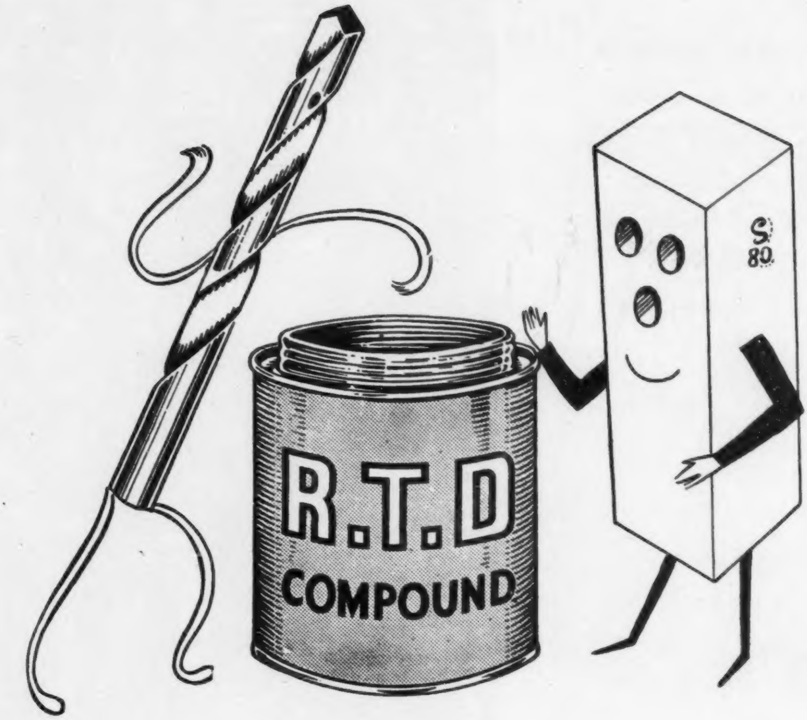
You can count on STALKER for all your needs in small tools. We produce a comprehensive range including twist drills, reamers, milling cutters, hollow mills, end mills, etc. Note, too, that STALKERIDE carbide tipped drills and reamers are available in many sizes. Ask about LUBRICOLD Oil Feed Drills.

if it's small tools you need...

STALKER

THE STALKER DRILL WORKS LIMITED · DRILL SQUARE · SHEFFIELD, 6



'Between you and me' (SAID THE DRILL)

'I like a spot of R.T.D.'

" Me too," said Stainless (with a steely glance),
" especially when I'm under pressure."
" *It does avoid a lot of friction,*" *agreed the Drill.*
" *D'you know, the other day I almost had a seizure.*"
" Drills run free with R.T.D.," said Stainless,
" and don't you forget it makes things smoother for the likes of us, as well."
" *Just the stuff when the drilling's tough,*" *replied the Drill.* " *And saves me growing old before my time !*"

Write to ROCOL about R.T.D.

ROCOL LTD. IBEX HOUSE, MINORIES, LONDON, E.C.3. *Tel : ROYal 4372*
ROCOL HOUSE, SWILLINGTON, Nr. LEEDS. *Tel : Garforth 2261/2*

ROCOL R.T.D. COMPOUND does indeed prolong the life of drills (in fact, *all* cutting tools) many times over, and obtains a higher finish. Lubricate with R.T.D. when working with tough metals, including stainless steel, alloy steels and nickel alloys. Write for the Brochure, giving technical information and over twenty actual case histories.

A Rocol PRODUCT

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ARCHDALE 28"

COMBINES ACCURACY WITH THE POWER AND SPEED TO REDUCE COSTS

- **ANTI-BACKLASH DEVICE**
- **BUILT-IN CLIMB MILLING**
- **REVERSIBLE LONGITUDINAL FEEDS**
- **QUICK POWER TRAVERSE**

These sturdy and powerful machines, with their many outstanding features, mean increased milling efficiency wherever they are installed. Forgrove Machinery Co. Ltd., Leeds, are no exception, and in this modern factory ARCHDALE machines are setting the pace on a variety of work, such as the straddle milling of cast iron twist boxes as shown. Six speeds, 30/462 r.p.m. with eight feeds from 0·7in. to 15·5in. per minute.

Complete details gladly sent on request.

JAMES ARCHDALE & CO., LTD., LEDSAM STREET, BIRMINGHAM, 16

A Member of the Stavely Coal & Iron Co. Ltd. Group. *Telephone:* EDGbaston 2276

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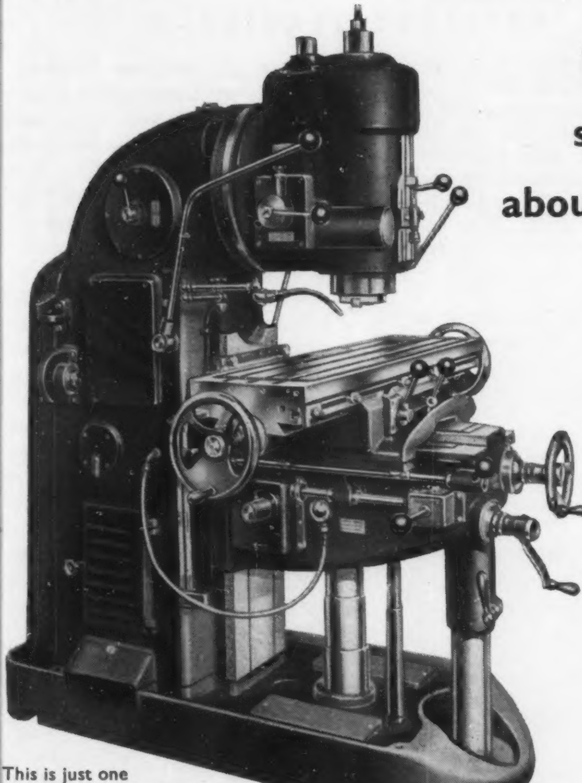

This is just one of the many refinements you can obtain!

three men
speak their mind
about their machines . . .

A Works Manager says:

Among the many excellent features of VF 1, I want to emphasise the extra support pillar for the knee as well as the spindle enclosure. Besides hand feed, VF 1 has power feed with variable feed pressure and automatic release against an adjustable micrometer stop. The spindle head is moreover swivelling, and can be adjusted accurately. Final judgment. Powerful construction which gives it the precision we want and must have.

A Planning Manager says:

I am naturally especially interested in the practical and well thought out accessories which can be obtained. Take for example the large round feed table with machine feed and dividing plate, or multiple stop for the spindle adjustment, as well as the easily mounted quick milling apparatus. That the machine, by having double-length feed screws, can be used for climb milling makes it doubly valuable.

A Purchasing Manager says:

During my years as buyer I have learnt one fundamental thing, which I will readily share. A machine is never better than the service the manufacturer can give. That was also a thing I checked carefully before we decided on VF 1. We were promised perfect service, and practice has also shown that the type of service Köping gives is just right for us on the purchasing side.

Three men with a common denominator . . .

KÖPING VF I

Curve milling on VF I with circular feed table and power driven circular feed.

There is so much more we would like to tell you about VF 1. We have a brochure for you packed with valuable and interesting facts about a machine which can be the right one to increase production at your works. Send us a line, and you will receive it by return of post.

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MORTIMER ENGINEERING COMPANY
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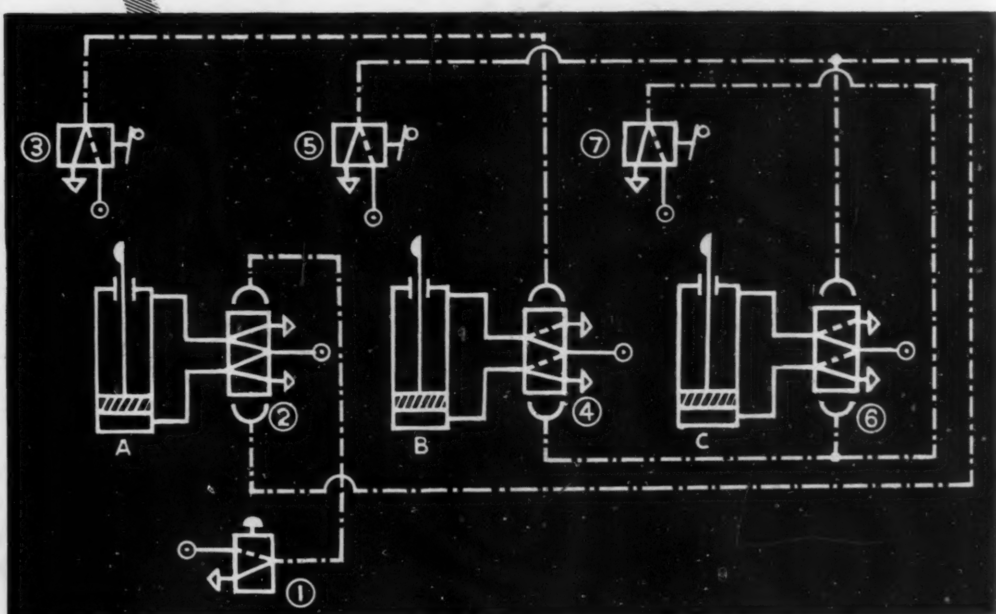
MARTONAIR TECHNICAL ADVISORY SERVICE—7

The circuit contains three cylinders, sequentially operated, and is a further example of the type of sequential control that can be obtained. The cycle shown is: A+, B+, C+ A—, B— C—. The cylinders do not necessarily operate in the same direction or in the same plane, and re-arrangement of the piping or components could provide many variations on this sequence.

Depression of the push-button of the three-port valve (1) reverses valve (2) and outstrokes cylinder (A). Roller-operated three-port valve (3) is tripped, reversing valve (4). Cylinder (B) outstrokes. Valve (5) is tripped, reversing valve (6) to outstroke cylinder (C). At the same time, valve (2) is returned to its original position to instroke cylinder (A).

As cylinder (C) completes its stroke, valve (7) is tripped and supplies a signal to return valves (4) and (6) to their original positions and thus return or instroke cylinders (B) and (C). Flow regulators may be fitted to control the speeds of the cylinders, and if necessary, valves could be fitted to prevent a movement should an earlier movement not be completed. Thus, if it should be essential that (B) and (C) should not return to the position shown until (A) has completed a slow return, the air supply for valve (7) could be taken through a roller operated three-port valve fitted in such a position as to be depressed by the trip or cam on the piston rod of cylinder (A) in its inward position.



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PARKSHOT · RICHMOND · SURREY · ENGLAND

TELEPHONE : RICHMOND 2201 (6 lines)

The Martonair Technical Service is freely at your disposal at all times. Fully qualified to advise on all aspects of applied pneumatics, the Service is backed by a staff of technical representatives in Great Britain, and by overseas offices and manufacturing companies.

Copies of this advertisement and earlier issues in this series are available from Martonair Limited.

MANUFACTURERS OF PNEUMATIC HOISTS · CYLINDERS · CONTROL VALVES AND ACCESSORIES

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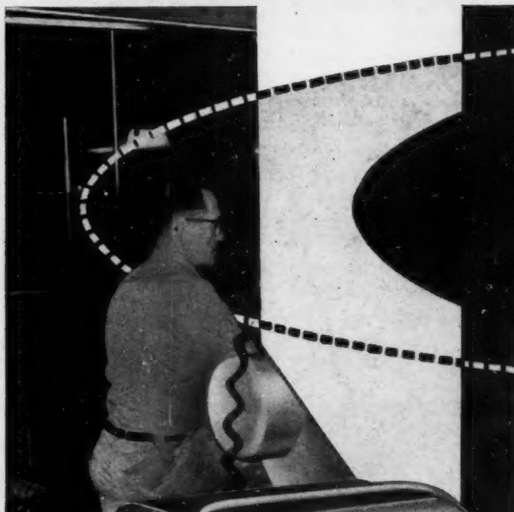
MARBAIX

FOR UNUSUAL MACHINES



BARNESDRIL COOLANT FILTERS

. . . assure continuous high quality and surface finish PLUS lower costs all round

"Savings are secondary to the quality control we have gained in the use of BarnesdriL Kleenall Filters. The Filters have allowed us to keep ahead of our competition in the quality of our product."

This statement was made by the Plant Superintendent of a prominent roller bearing manufacturer. A centreless grinder (shown) and a super-finisher are used for surface finishing and bringing bearings to their final accuracies. Both are equipped with BarnesdriL Kleenall Combination Magnetic and Fabric Coolant Filters. The bearings, used in guided missiles, aviation electrical motors, and transportation equipment, are finished to 2 to 3 RMS. micro-inches. Size must be held to $\pm 0{\cdot}000025$in. and their crowns held to $0{\cdot}0001$in., checked by electronic measuring device.

By filtering the re-circulated coolant through Kleenall Filters, definite production savings are also accrued. Less coolant and less labour are required and equipment lasts longer. If quality control or extreme accuracy are part of your production requirements, write to Dept. M.18 for full details of Kleenall Filter.

ORIGINATORS OF THE DRUM TYPE MAGNETIC AND COMBINATION SEPARATORS.

MADE IN GREAT BRITAIN

Patents Nos. 603083, 731655 and 745604; others pending

THE CENTRELESS GRINDER WITH A BARNESDRIL MODEL MP-15 KLEENALL COMBINATION MAGNETIC AND FABRIC FILTER.

GASTON E. MARBAIX LTD

DEVONSHIRE HOUSE, VICARAGE CRESCENT, BATTERSEA, LONDON, S.W.11

PHONE BATTERSEA 8888 (8 lines)

MARBAIX

FOR UNUSUAL MACHINES

MARBAIX-NASH

Rotary Finishers

FOR ULTRA FAST FLASH REMOVAL, GRINDING, BUFFING, ETC., ON CIRCULAR MOULDED AND MACHINED PARTS

MODEL 103

- **UNSURPASSED PRODUCTION RATES**
- **CONTINUOUS TURRET OPERATION**
- **VARIABLE TURRET AND SPINDLE SPEEDS ADJUSTABLE WHILE RUNNING**
- **PRODUCTION UP TO 70 PIECES PER MINUTE**

Here is a machine that really solves the problem of finishing circular mouldings and diecastings—AT UNSURPASSED PRODUCTION SPEEDS. Applications are almost unlimited, as it is possible to use cutters, carbide files, grinding and buffing wheels, abrasive and buffing belts—in fact, any type of tooling that can be mounted on the working arc of the back table.

MODEL 103-B is a similar machine operating with an intermittent motion and its index mechanism permits dwelling at tooling station
Production up to 20 pieces per minute

CAPACITY

Diameter range, ten spindles ..	0in. to 4½in.
Height range	0in. to 8in.
Number of spindles	..10

WRITE FOR FULL DETAILS AND PRODUCTION ESTIMATES TO DEPT. M.3.

GASTON E. MARBAIX LTD

DEVONSHIRE HOUSE VICARAGE CRESCENT
BATTERSEA LONDON S.W.11
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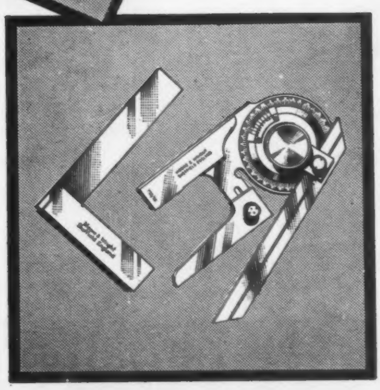
EXTERNAL & INTERNAL MICROMETERS···DEPTH GAUGE MICROMETERS···FEELER GAUGES

BEVELS···BEVEL PROTRACTORS···ENGINEERS SQUARES & STRAIGHT EDGES···SURFACE PLATES···PROTRACTORS

RADIUS GAUGES···SCREW PITCH GAUGES···SMALL HOLE GAUGES···SURFACE GAUGES···TELESCOPIC GAUGES

Where accuracy is essential...

manufactured to
BRITISH STANDARD
SPECIFICATION



• • • in machine shops, toolrooms and inspection departments, men who are accustomed to working to fine limits, like to work with quality tools they can trust, — tools upon whose accuracy they can rely. If accurate measurement is *YOUR* requirement, *REMEMBER* —

(M&W) Precision Tools measure up to any job

SEND 8½d. IN STAMPS FOR A COPY OF OUR LATEST CATALOGUE, MENTIONING THIS JOURNAL.

MOORE & WRIGHT (Sheffield) LTD., NORTON LANE, SHEFFIELD 8.

THE NEW SCRIVENER

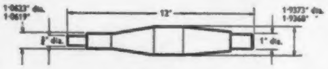
No. 3 Centreless Grinding Machine

The largest machine in the Scrivener range, this new Centreless Grinding Machine was introduced at the International Machine Tool Exhibition, and received wide approbation.

Employing the Scrivener system of controlled cycle operation, it demonstrated the plunge grinding of a stub axle in a total cycle time of 30 seconds (for two operations).

Scrivener machines incorporate, in addition to features for straight-through or hand-operated plunge grinding, a system for semi- or fully-automatic controlled cycle operation. By adopting the latter method, very economical mass production rates can be achieved, the machines feed, grind and eject in sequence and can be incorporated into automatic production lines.

For continuous high production of precision ground parts the Scrivener feature of controlled cycle plunge grinding offers special economy unattainable by any other grinding method.
This example illustrates typical production.



Stub Axle. Plunge grinding two dia. (±0.0002") and two tapers (to gauge) magazine feed.

Total time. 30 seconds. 120 pieces per hour. Stock removed 0.012" to 0.015" in two passes.

The complete range comprises:

Model	No. 1D	No. 2	No. 3
Grinding wheel dia. and width	12"×3"	20"×6"	20"×10"
Control wheel dia. and width ...	7"×3"	12"×6"	14"×10"
Max. opening between rear wheels...	2¼" *2"	6" *4½"	9" *9"

**Machines with controlled cycle operation.*

WICKMAN LIMITED

FACTORED MACHINE DIVISION, FLETCHAMSTEAD HIGHWAY, COVENTRY

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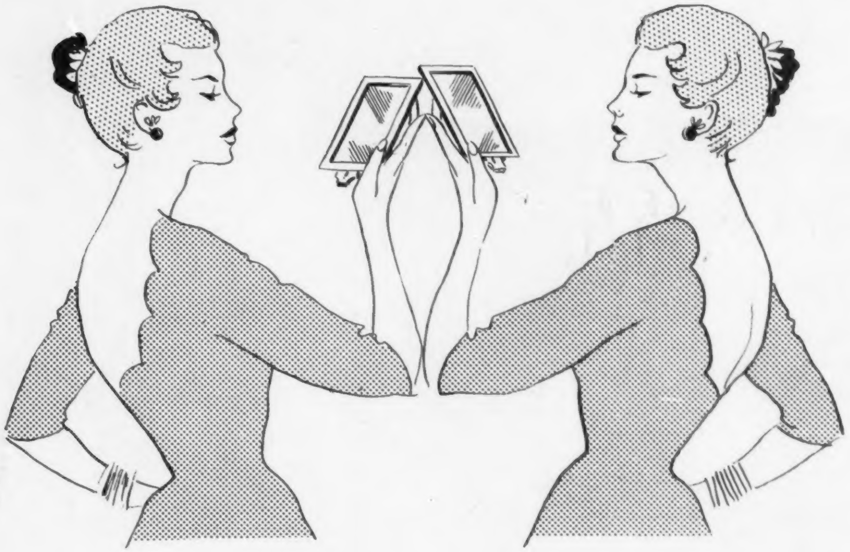

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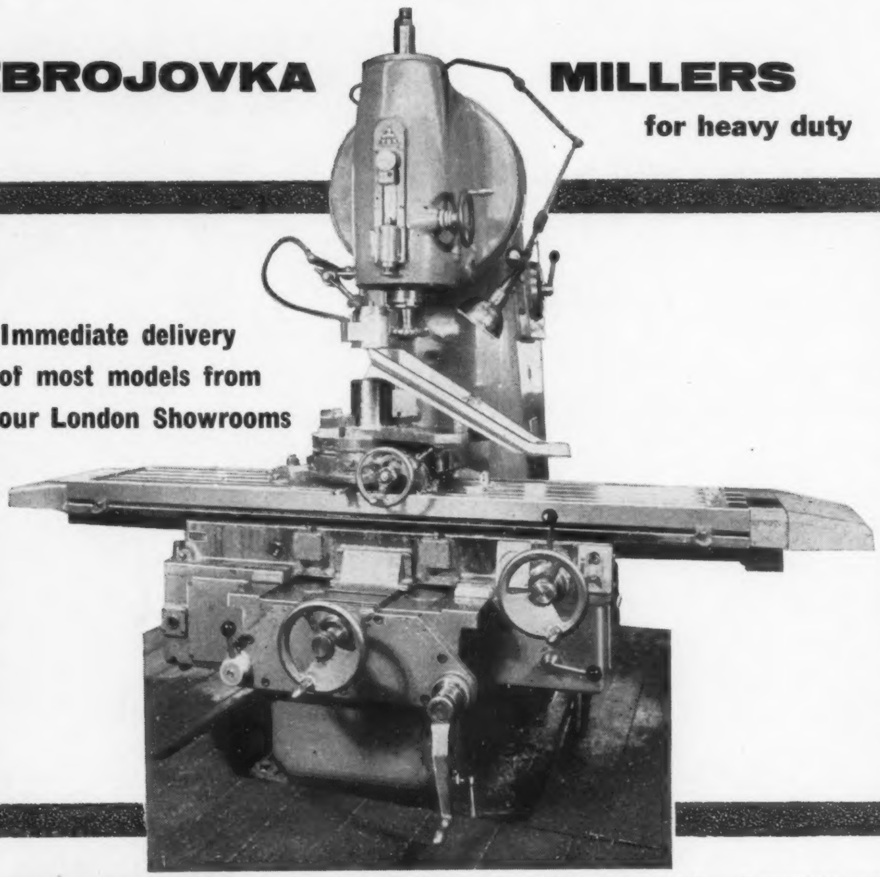

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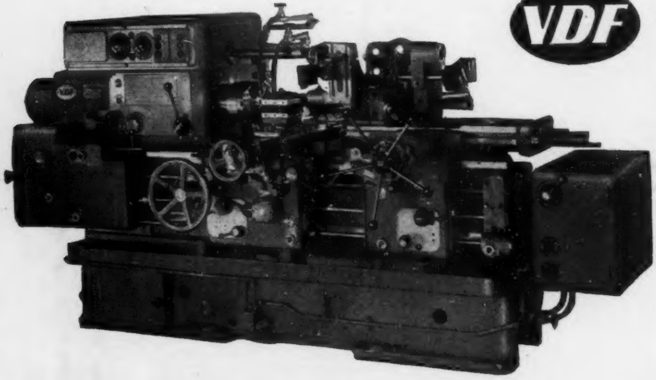

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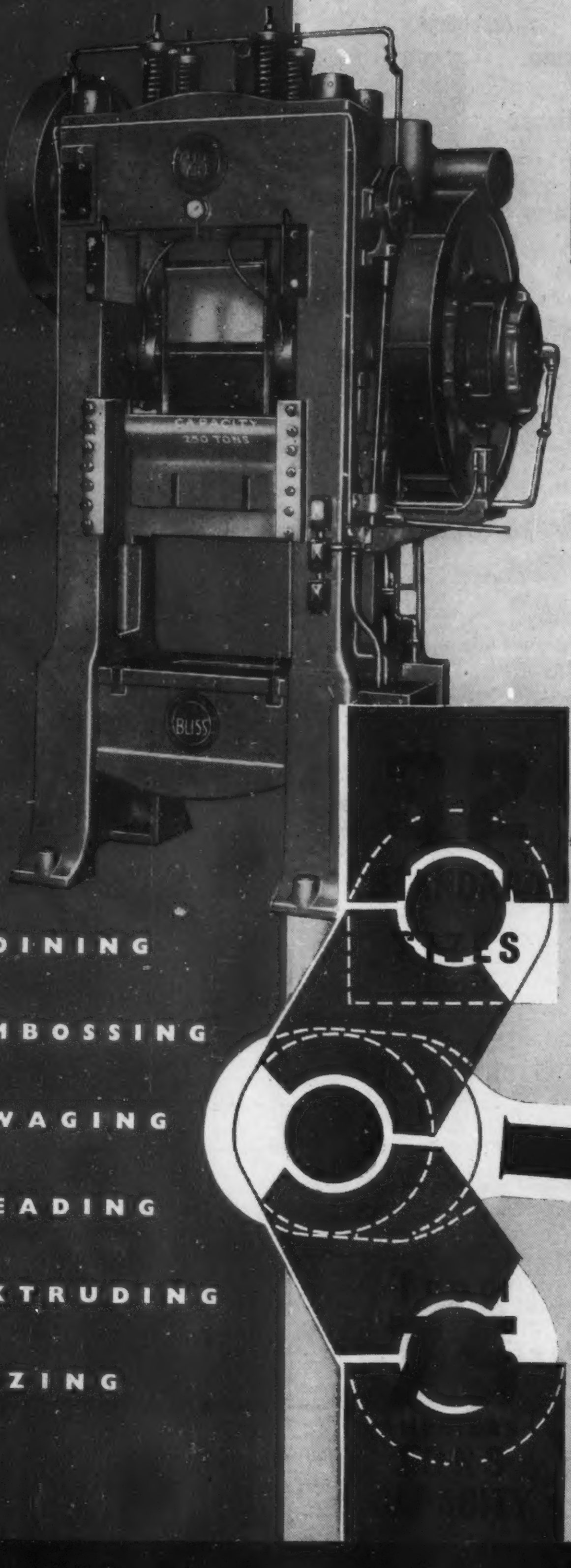

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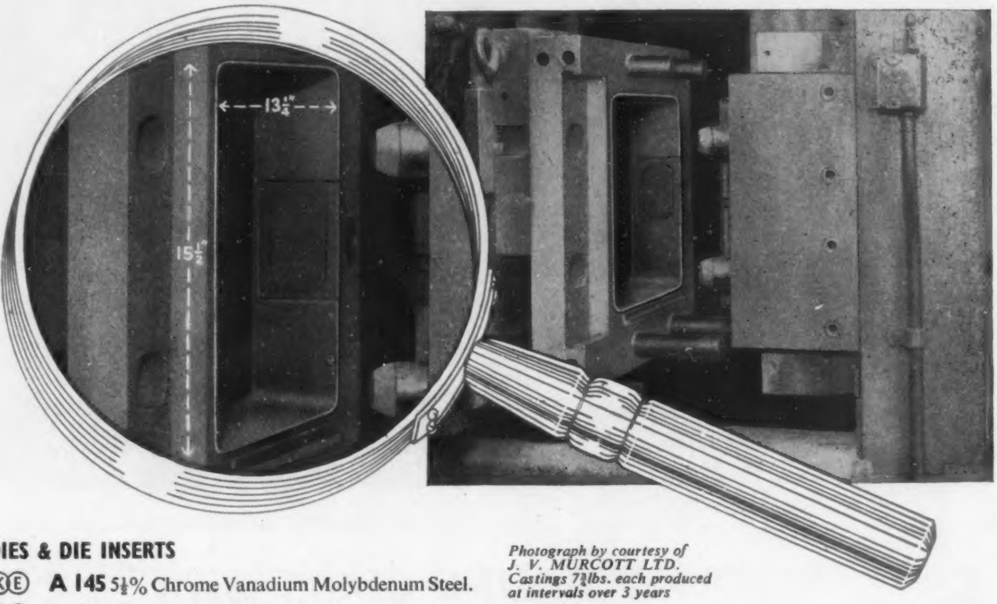

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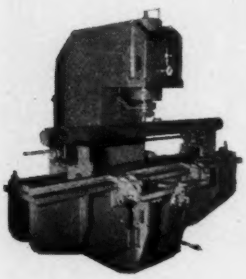

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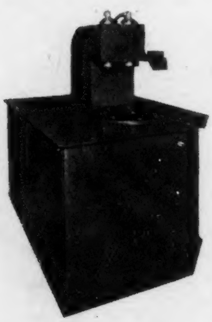

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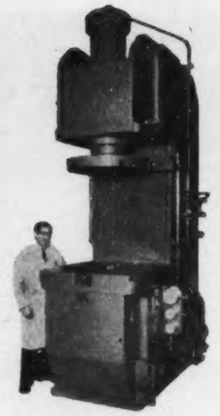

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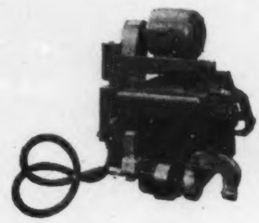

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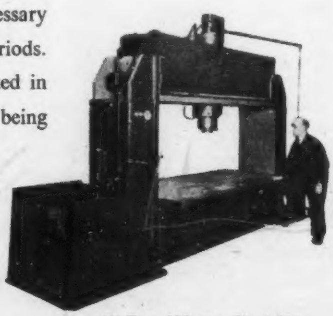

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CONTENTS

Abstracts of Principal Articles

The Production of Ball and Roller Bearings .... P. 1372

In this eighth article in a series describing some of the methods and equipment employed by the Hoffmann Manufacturing Co., Ltd., Chelmsford, Essex, the production of ball and roller races in the "B" factory is discussed. Large races, up to 72 in. diameter, are machined from forged rings, and the company has recently installed a number of large Acme-Gridley 4-spindle automatics for machining races from tube up to 7¾ in. diameter. Fay high speed automatics, driven by 50-h.p. motors, are employed for machining the tracks in races up to 9¾ in. diameter, using carbide-tipped negative rake form tools. Races exceeding 14½ in. diameter, up to the maximum produced, are machined complete on Swift type 16 SV 5 lathes, and are subsequently ground on Churchill 48-in. machines. In the extensive heat treatment department, low-carbon races are hardened by pack- and gas-carburizing, and for the latter process, the company have installed a large gas-fired, radiant-tube, Birlec pit-type furnace. A carburizing atmosphere is provided by a Birlec endothermic gas generator, the output of which is enriched with butane gas. The majority of the furnaces in the shop are regulated from a centralized control room. (MACHINERY, 92—13/6/58.)

Tightening and Tensile Tests on Joints Assembled with Bolts Threaded BSW, BSF, UNC and UNF .... P. 1381

The static strengths of BSW, BSF, UNC and UNF bolt-nut combinations have been compared under various conditions of tightening, with a particular view to checking the suitability of UNF threads for general use. Tests were carried out under single and repeated tightening, and some of the nuts were bored out to simulate conditions resulting from the use of an oversize tapping drill. While the UNF combinations were at least as strong as the other types for a single tightening, many of them failed by thread bending and stripping and they were not so resistant to repeated tightening as the other types. For satisfactory use of UNF combinations, tightening must not be sufficient to cause yield. It is suggested that UNC threads would generally be preferable in heavy applications where close control of tightening is not possible. In changing over from Whitworth to Unified threads, each case should be considered on its merits, and UNF should not be taken as an automatic replacement for BSF. (MACHINERY, 92—13/6/58.)

Conference on Compressed Air as an Aid to Improving Productivity .... P. 1401

At a conference which was organized recently by the Cornwall section of the Institution of Production Engineers, papers were read on subjects ranging from the design of compressors to the use of compressed air for machine operation and gauging. In connection with the latter, this article includes an example of a multi-dimensional gauging unit built into an in-line transfer machine. Descriptions are also given of the use of pneumatic equipment to reduce operator fatigue and details are included of a 24-station, air-operated, fully-automatic machine for assembling small parts used in the radio industry. (MACHINERY, 92—13/6/58.)

Blanking "Number" Anodes from Thin Strip ....P. 1407

"Number" anodes from 0 to 9 are required for all-electronic numerical indicator tubes for computers and their production presents unusual problems. These numbers are made from 0·005-in. thick strip, and the proportions must be such as to permit clear reading when they are superimposed in a stack. For this reason, the width of metal forming the outline of a number may be as little as 0·007 in. It is also necessary that the various numbers should have approximately equal surface areas. In this article are described press tools which have been developed for blanking these numbers. Only very small clearance is permissible between the punches and dies, and it is stated that the value is of the order of 0·0002 in. At the final stage in machining the die apertures, the previously hardened punches were employed as broaches. (MACHINERY, 92—13/6/58.)

Holbrook Precision Mould Maker's Lathe ....P. 1410

The lathe described in this article has been developed from the company's type 15/20 machine, and particular attention has been paid to versatility. A slow-speed unit is provided for the headstock, and other features include a pitch variator, hydraulic copying slides, internal and external thread milling heads, also internal and external grinding attachments complete with diamond wheel dressers. A rotating master, driven from the headstock spindle, can be employed when it is required to produce parts of non-circular form. (MACHINERY, 92—13/6/58.)

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IN FORTHCOMING ISSUES

The new Vauxhall press shop—Gauges for checking workpieces with conical ends—The production of precision studs for severe duties.

Precision Sand Casting

The advantages which can be gained by casting many parts hitherto made by other methods, such as forging and machining, or machining from the solid, provided that the desired physical properties, dimensional accuracy, and surface finish can be obtained, are now increasingly recognized. In recent years, moreover, there have been numerous advances in the field of precision casting which have enabled greatly improved results to be achieved in various directions. For example, certain parts are now successfully cast in semi-permanent moulds made from high-grade refractory, and there has been great activity in connection with expendable mould processes based on the use of sand with an organic binder (shell moulding) or refractory with an inorganic binder (investment casting). Reports have recently been received, moreover, concerning what may be regarded as an interesting combination of the shell moulding and carbon dioxide techniques, whereby fairly thick shells of great strength are produced. These various methods undoubtedly offer important advantages within their particular spheres of application, but their wider adoption has been restricted by reason of the cost of tooling or mould materials. Commenting on the prevailing situation, in the introduction to a paper which he presented at the conference on Technology of Engineering Manufacture, organized by the Institution of Mechanical Engineers, Mr. J. S. Turnbull, A.M.I.Mech.E., expressed the following opinions: "there are in industry today countless thousands of cases where components are machined from forged or extruded bar, which could have been made as castings requiring considerably less machining. In an age when machining costs are high and skilled labour is scarce, it is of the utmost importance that methods of liquid forming should be used effectively with a view to reducing or eliminating man-machine hours."

In this connection it was pointed out that, owing to the difficulties of casting steel by the methods hitherto available, the output of castings in this material is only about 300,000 tons, whereas the annual production of steel is now of the order of 22,000,000 tons. It was also suggested that if any substantial change in this situation is to be brought about, it will be necessary to bridge the gap between sandcasting and investment casting, so as to incorporate "the best features of each in order to obtain solid castings associated with the best possible economy of process operation."

The problem must be considered under two main headings, namely the supply of molten metal and the provision of satisfactory moulds, and after drawing attention to the difficulties associated with steel melting in an investment foundry, Mr. Turnbull advocated that "the precision foundry of the future should be built into the existing foundry or, alternatively, into any other organization where liquid steel is available in bulk." He then went on to discuss the Alphax process, which has been developed by his company to overcome some of the limitations associated with other methods of precision casting.

For this process, silica sand is not satisfactory, and zircon or other suitable material is employed in conjunction with a water-base, high-temperature phosphate binder. The sand and binder are mixed to a putty-like consistency, and it is one of the virtues of the process that moulding can then be carried out by hand or pneumatic ramming, with simple wood patterns, where only small quantities are required, by hydraulic pressing, with metal or plastics patterns, or by a combined core blowing and hydraulic pressing technique. The adaptability for both large and small outputs, characteristic of normal sand moulding, is thus preserved. Hydraulic pressures up to 5 tons per sq. in. are employed, and where the blowing and pressing procedure is followed, a considerable degree of mechanization can be achieved.

Green moulds may be allowed to harden in air, but are normally heated in a low-temperature oven, or subjected to the action of ammonia gas, which ensures rapid hardening, and are assembled with a high-temperature adhesive in preparation for firing. For the latter operation, temperatures up to 750 deg. C. are employed, to purge the moulds of any organic matter and ensure adequate permeability. Casting is carried out with the moulds hot, the normal temperature range being 200 to 500 deg. C., and this procedure offers the advantages that the air in the cavities is already expanded, and solidification of the castings is much slower.

As would be expected from this brief description, the costs of castings made by this method are intermediate between those associated with the investment and orthodox sand processes, but the

(*Continued on page* 1424)

The Production of Ball and Roller Bearings

Methods Employed by the Hoffmann Manufacturing Co., Ltd.

In earlier articles in MACHINERY, 91/664—20/9/57, and 91/1012—1/11/57, reference was made to some of the methods employed by the Hoffmann Manufacturing Co., Ltd., Chelmsford, Essex, for producing ball-bearing races on their No. 1 line. This line, it may be recalled, is devoted to races up to 4 in. diameter, in sizes for which there is a large demand. Two subsequent articles (92/640—21/3/58, and 92/779—4/4/58) were devoted to ball and roller cage manufacture, in a large specialized department concerned entirely with this work. Here, some of the operations on larger races, up to the maximum size produced by the company, are considered.

The Chelmsford works comprise three factories, designated "A," "B" and "C," and "A" factory is devoted to the production of balls and rollers (MACHINERY, 90/14—4/1/57, 90/680—29/3/57, and 90/1256—7/6/57). The No. 1 line is installed in "C" factory, and "B" factory, with which this article is concerned, is responsible for the manufacture of races for bearings which are required in smaller quantities. These bearings include standard types from 1¼ in. to 26 in. diameter, and special types up to 72 in. diameter. All roller races, it may be noted, are produced in "B" factory, which also houses the large centralized heat-treatment shop, a forging shop, and a special department for the manufacture of grinding wheels, for use in the various departments.

Races of the smaller sizes are produced from high-carbon steel bar and tube, but the larger sizes are machined from forged rings of high- and low-carbon steel. Rings of $3\frac{9}{16}$ in. to 7¾ in. diameter are made from bar, by hot upsetting on horizontal forging presses, and a proportion of the forged blanks required is produced on Massey hammers and a Rhodes press. Larger rings are obtained from specialist suppliers. The equipment of the ring forging shop includes two National machines (Buck & Hickman, Ltd.) of 3 in. and 5 in. capacity, and three Covmac machines (Coventry Machine Tool Works, Ltd.) of 3¾ in. and 6 in. capacity. A view of the large Covmac machine, in operation, is given in Fig. 1.

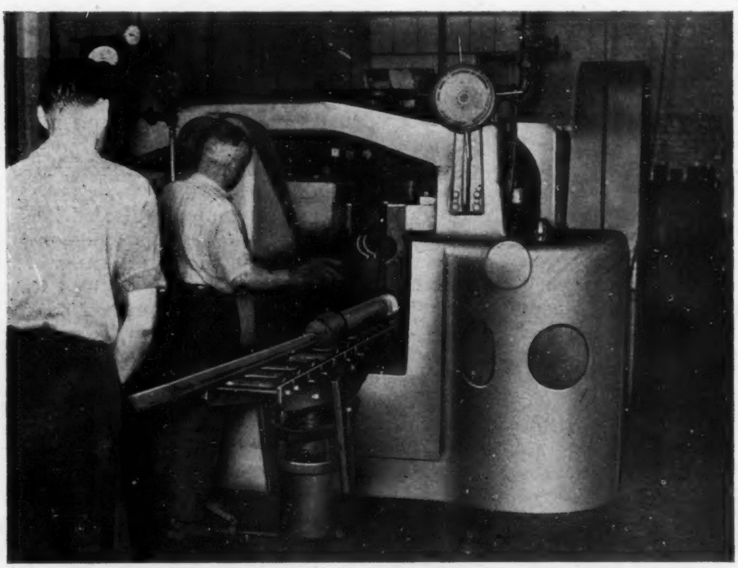

Fig. 1. This Large Covmac Machine, with a Capacity of 6 in., is Employed for Producing Rings From Bar, by Hot Upsetting, in Two Stages

On all these machines, the method of forging rings is the same, and 2-stage dies are employed. In Fig. 1, the Covmac machine is set up for forging rings of 7¼ in. diameter and $1\frac{25}{32}$ in. wide, with a bore-diameter of $5\frac{5}{16}$ in., from 4¾-in. diameter bar. The bars are heated in gas-fired furnaces installed at each side of the machine, and two rings are forged at each heat. A heated bar is taken from the furnace with the aid of an overhead hoist, and is placed on the air-operated lifting table seen in front of the machine. This table is provided with rollers, to facilitate feeding the bar between the split dies.

For the first stage, the bar is inserted in the lower station, against a

stop, and when the press is operated, it is gripped between the dies, and the end is upset to form a plain flat disc. The work is then raised to the second station, at which the central portion, integral with the bar, is punched out. In this instance, the die-aperture is a sliding fit for the bar, to enable the latter to be ejected. On the return stroke, the ring is released into a chute, which guides it into a well in the shop floor, whence it is withdrawn to cool. Meanwhile, the bar is returned to the lower position, in readiness for the next stage. At this set-up two rings are forged in 45 sec. The smaller machines are somewhat faster, and three rings can be forged per heat. When the bar-length is reduced to such an extent that it cannot be handled conveniently, it is electrically welded to a fresh length, and forging is continued. The ring containing the weld, and those adjacent to it, are scrapped.

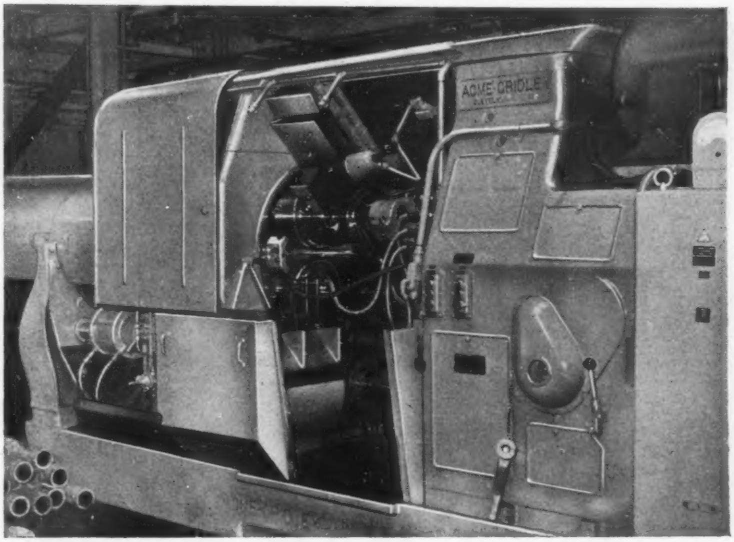

Fig. 2. One of the Large Acme-Gridley 4-spindle Automatics, Recently Installed for Machining Races from Tube up to 7¾ in. Diameter

LARGE-DIAMETER TUBE

Comparatively recently, the economic advantages of producing upset rings, within the size-range indicated, have been somewhat diminished by the availability of high-quality British-made tube in the requisite sizes, up to 7¾ in. diameter. This tube is sufficiently accurate and parallel for machining on automatic multi-spindle lathes, and its introduction has had a far-reaching effect on the firm's production policy. Hitherto, the machines in "B" factory have been arranged in groups according to function, but extensive reorganization is now in progress, in order that the full benefits may be gained from the use of tube for race production. As a part of this programme, the company is laying-down a No. 3 line, which will be generally similar to the No. 1 line, earlier described. In this connection, a number of large 4-spindle type RB. Acme-Gridley automatics, with a capacity of 7¾ in. diameter, have already been installed. Further reference will be made to these machines, one of which is shown in Fig. 2. As a result of these developments, the forging machines will shortly become obsolete, and will be removed to make way for the new No. 3 line.

GENERAL PROCEDURE

The general procedure for machining and heat-treating the races here considered, varies considerably according to the design and size of the bearing, also with the specification of the material, and the form in which it is initially received. For example, although high-carbon steel tube is, as already indicated, available in sizes up to 7¾ in. diameter, forged rings are nevertheless required for a proportion of races over 3½ in. diameter, both in high- and low-carbon steel. High-carbon steel rings produced by the company are first ground to remove flash left on the periphery by the forging dies, and are then annealed. If necessary, depending on the condition of the dies, any flash on the end face is then removed by turning. For the low-carbon rings, the procedure is generally similar, except that the work is not annealed.

A proportion of the forged rings within the size range at present produced by the company is also obtained from outside suppliers, and high-carbon rings in this category are received already annealed. These rings are hardness tested, and, if necessary, are re-annealed before machining. Larger bought-

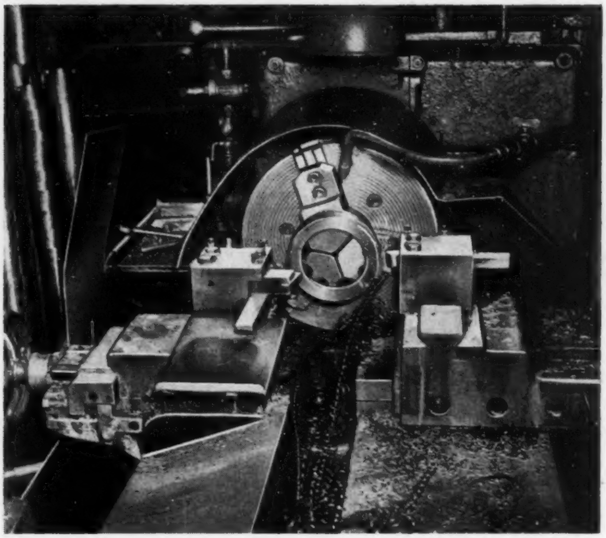

Fig. 3. Typical First Stage Set-up on a Drummond No. 1 Maxicut Lathe, for Machining Forged Rings. Wimet S.58 Carbide-tipped Tools are Employed

out rings of high-carbon steel are stress-relieved after the first rough machining stage, during which they are machined all over, and are subsequently finish machined, hardened, and ground. Low-carbon rings of 10 in. diameter and over are normalized after they have been rough machined, and are then shot blasted, finish machined, hardened, and ground.

On forged rings up to 9½ in. diameter, the initial rough machining is carried out in two stages on Drummond No. 1 Maxicut multi-tool lathes. At the first stage, the work is machined on the external surface and one face, and at the second, on the internal surface, and the second face. Rings in the size range indicated are finish-machined on 12-in. Churchill-Redman Fay lathes, again in two stages. At the first, the outside surface, one end face, and two corner radii are machined, and at the second, the bore and the remaining end face and radii. The tracks are machined in both inner and outer races, up to 9¾ in. diameter, on Fay high speed lathes.

The rough- and finish-machining stages on rings exceeding 9½ in. and up to 14½ in. diameter, are performed on Drummond Maximatic lathes, on which plain roller races, without tracks, are also finish machined, complete. Tracks in races from 9¾ in. up to 14½-in. diameter are machined on Jones & Lamson lathes (Charles Churchill & Co., Ltd.). Larger rings, of more than 14½-in. diameter, up to the maximum size produced, are machined in a "specials" section, equipped with Herbert No. 9A and large Swift turret lathes, also Jones and Lamson lathes. The Fay high-speed lathes, it may be noted, are also used for machining the tracks in races produced from tube.

A typical first stage set-up on one of the Drummond No. 1 Maxicut lathes, for machining a high-carbon steel forged ring, is shown in Fig. 3. The work is gripped internally by an air operated chuck, and Wimet grade S.58 carbide-tipped tools are employed. For the component illustrated, the front cross-slide tool machines the external diameter to 6·138/6·146 in., taking a cut approximately 0·05 in. deep. An auxiliary tool, also mounted in the front tool-post, chamfers the external corner. Meanwhile, the rear cross-slide tool faces the outer end to an overall width of 1·419 in. A feed of 0·013 in. is employed, and the floor-to-floor time is 1 min. Generally similar tooling is employed for the second stage, at which the opposite side is faced to give an overall width of 1·368/1·378 in., and the bore machined to 4·671/4·681 in. diameter.

MACHINING RACES FROM TUBE

The working zone of one of the large 4-spindle Acme-Gridley automatics, set up for machining races from 4⅝-in. diameter, 3½-in. bore, high-carbon steel tube, is shown in Fig. 4. At this set-up, all the tools, including those for parting off, are carbide tipped, and the feed of the main tool slide is 0·0097 in. per rev.

At station 4, the stock, previously rough turned externally at station 3, is fed out to a stop, and is rough bored to within 0·063 in. of finished size, with a boring-bar tool on the main slide. This tool is tipped with Wimet S.58. At the same station, the rear end of the work is broken down, and chamfered, and parting off is begun with a Wimet XL 3 cross-slide tool, at a feed of 0·002 in. per rev. This tool also chamfers the front corner of the next component.

Subsequently, at station 1, the external surface is finish turned to 4·510/4·514 in., with a knee tool on the main slide, and the internal surface is finished to 3·762/3·766 in. with a boring-bar **tool**

similar to that employed at station 4. At the same station, a Wimet XX form tool, mounted on the cross-slide, is fed in to machine the external ⅛-in. corner radii. The outer end is finish faced at station 2, with a cross-slide tool which is fed in at 0·002 in. per rev., and a 45-deg. chamfer is formed on the inner corner with a tool on the main slide. At station 3, the work is parted off to a width of 1·078/1·082 in., with a Wimet XL.3 cross-slide tool ¼ in. wide, and the stock is rough turned, for the next component, with a knee tool. Carbide tools have proved satisfactory for parting off at this set-up.

TRACK MACHINING

As already mentioned, the high speed Fay automatics are employed for machining the tracks in races produced from tube and forged rings, in sizes up to 9¾ in. diameter. These machines are driven by 50-h.p. motors, and both ball and roller tracks are machined in inner and outer races, using carbide-tipped, negative rake form tools. Swarf disposal presents certain problems, as it is impractical to provide chip breaker grooves, and separately attached chip breakers have been found unsatisfactory, since the swarf tends to jam beneath them. The rate of metal removal is high, and as the swarf takes the form of long continuous ribbons, with very little curl, it is bulky, and the machines must be cleared repeatedly.

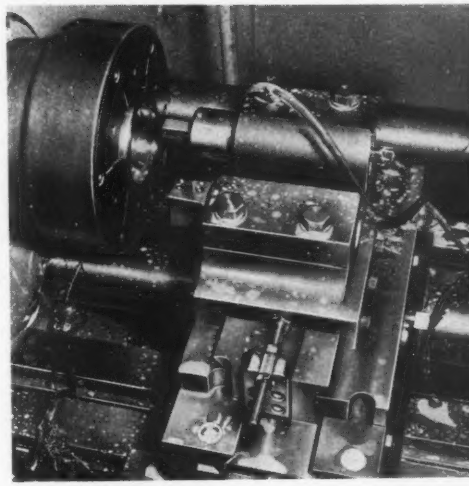

Fig. 5. Set-up for Machining the Ball Track in an Outer Race on a Fay Automatic, Using a Negative Rake Carbide-tipped Form Tool

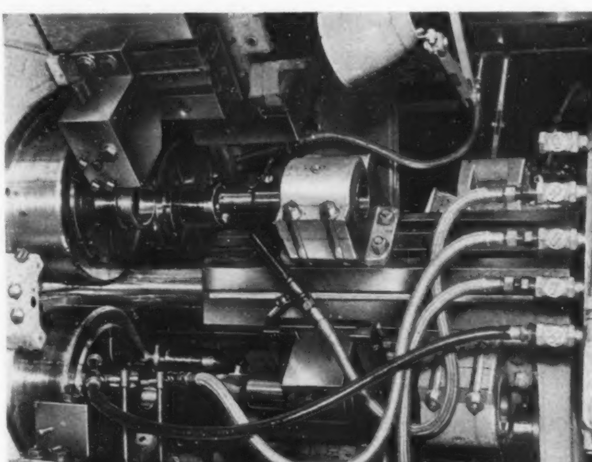

Fig. 4. Close-up View of the Working Zone of One of the Large Acme-Gridley Automatics, Set Up for Machining Outer Races from 4⅝-in. Diameter Tube

A typical set-up on one of these machines, for forming the ball track and internal corner radii in the outer race machined with the Acme-Gridley set-up described, is shown in Fig. 5. The work is inserted, against a back-stop, in an air-operated collet, with the parted-off face outwards, and is run at 482 r.p.m. When the automatic cycle is started, the tool slide is rapidly advanced, stopped in the required position, and then swung towards the rear to apply the Wimet XL 3 tools at a feed of 0·002 in. per rev.

The front tool is used to finish turn the parted-off face, and the rear tool is profiled to machine the track and the two internal corner-radii, simultaneously. At the end of the pass, the tool-slide is returned to the forward position, and then rapidly withdrawn. For inner races, the tooling arrangements are generally similar, except that the form and facing tools are transposed, and the work is gripped internally. A soluble oil coolant is employed.

Fig. 6. Machining a Large Race, of 27·1 in. External Diameter, on a Swift Type 16 SV 5 Lathe. These Machines are Employed for Races up to 50 in. Diameter

MACHINING LARGE RINGS

The larger rings, exceeding 14½ in. diameter and up to the maximum size produced, are machined by orthodox turning methods. In Fig. 6 is shown a typical set-up for a large roller outer race, on a Swift type 16 SV 5 lathe. When finish-machined, the component has an external diameter of 27·099/27·103 in., an internal diameter of 24·740/24·744 in., and a width of 3·540/3·544 in. The work is held in a 3-jaw chuck, with stepped jaws, and in order to minimize distortion, radial pressure is kept to a minimum, and flat clamps are applied to the end face. For the larger rings, face-plates of various sizes are employed, the largest of which has a diameter of 58 in.

For the component seen in Fig. 6, the low-carbon steel forged ring is approximately ¼ in., oversize on all four surfaces. Wimet S. 58 carbide-tipped tools are employed, and at the roughing stage the work is run at 40 r.p.m., and cuts approximately ⅛ in. deep are taken. Finish machining, to the dimensions indicated, is carried out at 60 r.p.m., with cuts approximately 0·02 in. deep. These lathes are also employed for machining the tracks in large ball races, for which high-speed steel form tools are used, and the corner radii on the edges of the tracks are machined at a separate operation.

HEAT TREATMENT

Heat-treatment of all rings in the categories here considered is carried out in the large shop already mentioned. For initial annealing, high-carbon forged rings, produced by the company, are subjected to an isothermal heat-treatment in Hoffmann gas-fired furnaces. They are raised to the austenitizing temperature of 820 deg. C., and are then allowed to cool slowly to the soaking temperature of 710 deg. C. On completion of the soaking period, the furnace is shut-down, or the work is withdrawn and allowed to cool in air. High-carbon upset forged blanks, of 1 in. to 10¾ in. diameter, are annealed in a similar manner. The larger high-carbon rings, after initial rough machining, are stress-relieved at 650 deg. C. to 700 deg. C., for 1 hour per sq. in. of cross-sectional area. Low-carbon rings, of 10 in. diameter and over, are normalized, after rough machining, at 950 to 1,000 deg. C., for 1 hour per sq. in. of section.

The hardening of high-carbon steel races, after they have been finish machined, is carried out at temperatures of 828 deg. C. to 840 deg. C., accord-

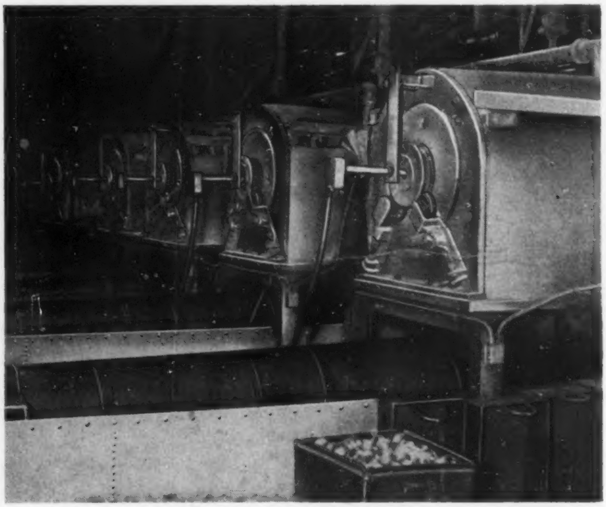

Fig. 7. Hoffmann Rotary Furnaces, of the Type Shown, are Employed for the Heat-treatment of the Smaller Races, also Balls and Rollers

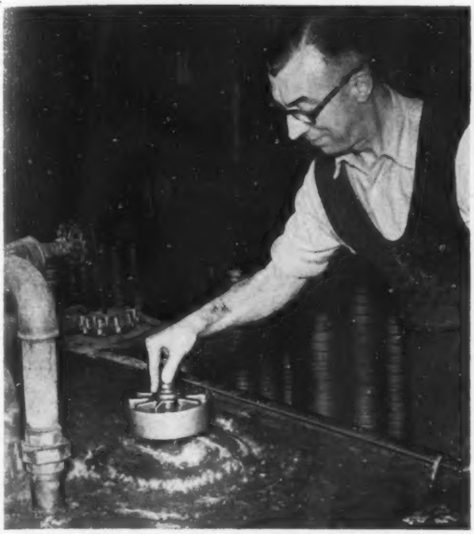

Fig. 8. Special Mandrels, and Submerged-jet Quenching Heads, are Employed for Hardening the Larger Races, as Here Shown

ing to the section weight, and, for this purpose, several different methods are employed. For the smaller races, such as those produced from bar and tube, which are of light section in relation to diameter, a salt-bath treatment, generally similar to that performed in the No. 1 line (MACHINERY, 91/676—20/9/57) is employed. Small races, of comparatively heavy section, are hardened in Hoffmann gas-fired, thermostatically controlled, rotary furnaces of the type shown in Fig. 7, which are also employed for the heat-treatment of balls and rollers. Each of these furnaces incorporates a power-driven, spirally-grooved, nickel-chromium alloy drum, which feeds the work through the heating zone. The rate of rotation can be varied, so that the duration of the heating cycle may be adjusted, as required.

At the delivery end of the drum, the heated components fall through an enclosed vertical chute into an oil quench tank arranged below the furnace, where they are guided into the end of a long drum of perforated metal. This drum rotates slowly, and is slightly inclined, so that the work is gradually fed through the quenching medium, to the opposite end. In this way, thorough cooling is ensured. At the delivery end of the drum, the work is discharged into a wire basket, placed on the floor of the tank. A proportion of small work is also hardened in shaker-hearth furnaces. The remainder of the races in the size-range here considered are heated in rotary-hearth furnaces, and all the high-carbon steel workpieces are quenched in oil.

As a precaution against distortion, the larger races are placed on quenching arbors. Each arbor comprises a pair of star-shaped members, which are stepped on the outer ends of the arms, to fit the bore and end faces of the work. These members are inserted in opposite ends of the race, and are held loosely together on a central pin, whereby the assembly is lowered into the quenching tank. To ensure rapid and even cooling, the quenching medium is agitated by means of submerged jets. The quenching heads are of various sizes, and are used interchangeably, according to the diameter of the work.

A typical head comprises a manifold ring, with a series of vertical limbs, equal in number to the arms of the star-shaped members. There are uniformly spaced holes in these vertical limbs, all facing in the same direction, through which the quenching medium is pumped, so that a powerful

Fig. 9. Typical Line of Hoffmann Pack-carburizing Furnaces, Showing Rail Trolleys Used to Facilitate Work Handling

swirling action is obtained. Quenching is carried out by lowering the work and mandrel assembly over the head, so that the vertical limbs enter the spaces between the arms of the star-shaped members. Heads of this type are also used with water, which is employed as the quenching medium when hardening carburized low-carbon steel races. A typical water quench set-up is shown in use in Fig. 8, and the swirling action resulting from the submerged jets may clearly be seen. As the mandrels are only in contact with the heated work for a short period before immersion, they remain cool enough for handling without tongs.

CARBURIZING

All low-carbon races which are carburized are treated to provide a controlled case depth from 0·020 in. to 0·400 in. The depth is controlled by the duration of the treatment, which, for pack-carburized work, ranges from 6 to 150 hours. Pack carburizing is carried out in Hoffmann gas-fired furnaces, some of which are seen in Fig. 9. Handling and loading are facilitated by the rail-trolleys, on which the packs are transferred, after treatment, to a cooling shed, located at the end of the main shop.

After they have cooled, the packs are emptied, and the work is subsequently normalized. This latter treatment is carried out in gas-fired furnaces at 900 deg. C., in an oxidizing atmosphere, for 30 to 60 min., according to the size of the components, and the weight of the charge. At the end of this period, the work is withdrawn and allowed to cool in still air, after which it is shot blasted, hardened, again shot blasted, and tempered.

Fig. 10. This Large Pit-type Birlec Furnace is Employed for Gas-carburizing Low-carbon Steel Races. A Typical Charge is Seen Above the Water-jacketed Cooling Pit

Gas carburizing is also employed, and for this purpose the company has installed the large pit type radiant-tube Birlec furnace seen in the foreground in Fig. 10, which also shows the two associated cooling pits. The pit nearest the furnace has a water jacket, and an air-circulating fan in the bottom, to promote rapid cooling, and is provided with a sand-seal cover so that the interior can be isolated from the atmosphere. The second pit is not water cooled, and is open to the atmosphere at the top and bottom. A fan in the bottom provides a strong upward current of air. The work carriers, one of which is seen in use in Fig. 10, are of nickel-chromium steel, and are handled with the aid of a gantry crane.

The carburizing furnace is fired by producer gas, which is passed through carbonate of lime in order to remove sulphur, and thus avoid damage to the nickel-chromium steel radiant tubes. A carburizing atmosphere is provided by a Birlec gas generator, in which town's gas and air, in a 2:1 ratio, are heated electrically to 1,100 deg. C. This atmosphere is enriched by the controlled addition of butane gas, and the resulting mixture is fed to the furnace, in which a temperature of 950 deg. C. is maintained. After the necessary carburizing period, the work is transferred to the water-jacketed cooling pit, and when it has cooled, is returned to the carburizing furnace for normalizing. A carburizing atmosphere is again maintained, in order to prevent carbon loss, and the treatment, for a full charge, occupies approximately 2 hours. In this instance, the work is cooled in the second of the two pits mentioned, with forced draught.

The hardening of all carburized races is carried out by heating them in Hoffmann gas-fired furnaces, at 760-790 deg. C., according to the section-weight, and the specification of the material. As already indicated, they are quenched in water on mandrels, with the aid of submerged-jet heads of the type described in connection with the quenching of high-carbon components in oil. All hardened races, whether carburized or made from high-carbon steel are then tempered to give a Brinell hardness ranging from 825 to 900. For this purpose, Hoffmann, Wild-Barfield, and Homo (Integra Leeds & Northrup) electrically-heated, forced air circulation, ovens are employed, in

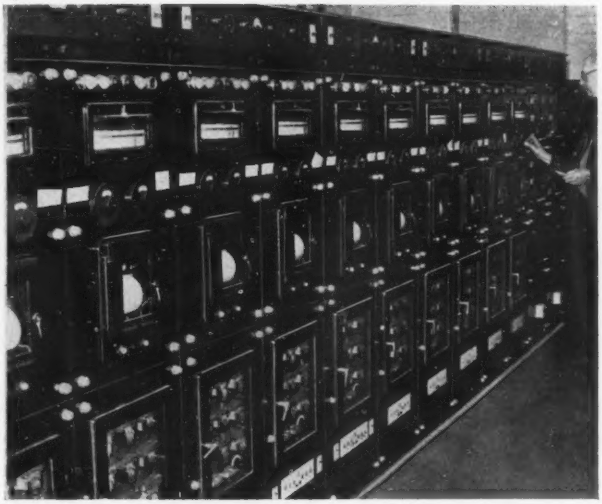

Fig. 11. One of Several Banks of Instruments in the Centralized Control Room for the Heat-treatment Shop. Coloured Light Signals Indicate Whether the Furnace Temperature is High, Correct or Low, and are Duplicated at the Furnaces

which the high-carbon components are heated to 125 deg. C., and the carburized components to 150 deg. C., followed by natural cooling in air.

CENTRALIZED CONTROL SYSTEM

With a few exceptions, such as the pack- and gas-carburizing units, all the furnaces in the heat-treatment shop are automatically regulated from a centralized control room, part of the instrumentation of which is shown in Fig. 11. Devised by the company, the system incorporates multi-channel recorder type equipment by Cambridge Instrument Co., Ltd., George Kent, Ltd., and Electro-flo Meters Co., Ltd. In Fig. 11, a typical bank of 2-channel panels is seen, and beyond the far end there is a number of 6-channel panels. Each 2-channel panel incorporates a set of signal lamps, a temperature indicating instrument, a recorder, and two temperature setting controls. Each channel corresponds to one furnace, and the indicating and recording equipment is automatically switched from one channel to the other, at short pre-determined intervals, so that virtually-continuous indications and records are obtained for both furnaces. Similarly, 6-channel panels serve six furnaces.

The signal lamps on each 2-channel equipment comprise two sets of three, and each set corresponds to one furnace. These lamps are red, white, and green, and are illuminated automatically to indicate whether the temperature of the furnace concerned is "high," "correct," or "low." These light signals are duplicated at the furnaces, two of which are tended by each operator, and two attendants in the control room are responsible for maintaining correct temperature. A separate temperature setting control is provided for each furnace, in the form of a calibrated adjustable dial. Each furnace is provided with two thermocouples, one of which serves the recorder equipment, and the other, the temperature control equipment and the signal lamps. The furnaceman enters, on a card, all particulars of the heating schedule required. This card is handed in at the control room, where the attendants ensure that the requirements are met. The cards are subsequently filed with the instrument records, for each batch.

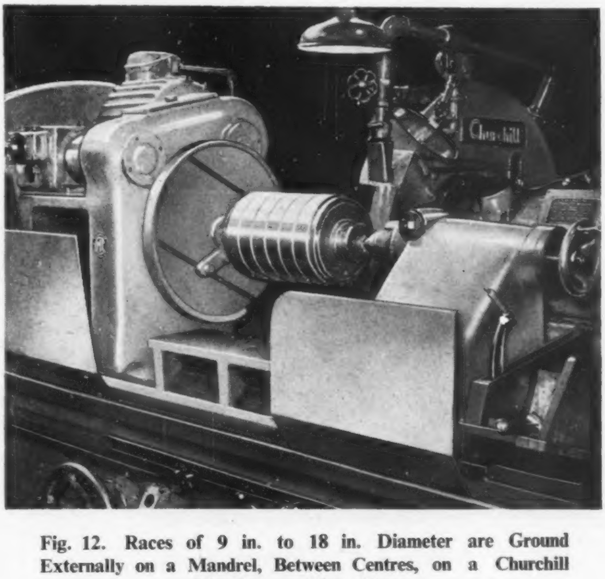

Fig. 12. Races of 9 in. to 18 in. Diameter are Ground Externally on a Mandrel, Between Centres, on a Churchill Machine, as Here Shown

GRINDING

The smaller and intermediate sizes of races in the range here discussed are ground by methods which are generally similar to those employed in the No. 1 line, and the first operation after hardening provides for grinding to width. For this purpose, Blanchard and Gardner face grinding machines are employed, and the races are then ground externally on Cincinnati centreless machines. Internal grinders of various types, including Bryant and U.V.A., are employed for the bores, and Bryant, Heald, and Van Norman machines are among those employed for grinding tracks.

Larger races, from 9 in. to 18 in. diameter, which cannot conveniently be ground externally by the centreless method, are mounted between centres, on mandrels, as shown in Fig. 12. At this set-up, on a 36-in. Churchill cylindrical grinder, a 30-in. diameter grade BA 463 J5 VBLU Carborundum wheel, 3 in. wide, is run at 730 r.p.m. The races are clamped axially by end-plates on a 2-in. diameter mandrel, which accommodates six at a time, and are aligned with the aid of a dial-gauge before the end-plates are tightened fully. Driven at 90 r.p.m., against the rotation of the wheel, the work is ground to 9·8425 in. diameter, to limits of +0·000 in., −0·0007 in.

All grinding operations on large races, such as those machined on the Swift type 16 SV 5 lathe, mentioned earlier, are performed on Churchill 48-in. machines, and a typical set-up is given in Fig. 13. The component shown is an outer race for an angular contact ball bearing, with the following finished dimensions. External diameter, 40·9985 in., +0·0002 in., −0·0013 in.; width, 3·7188 in., +0·000 in., − 0·002 in.; track diameter (nominal), 38·5 in.; and track radius, for 2-in. diameter balls, 1 in., +5 per cent, + 7½ per cent. The track diameter, it may be noted, is quoted as nominal, because the inner race track is ground to suit the outer, to give a controlled diametral clearance of 0·0268 in., ±0·0005 in. Despite their large size, the ovality of these races does not usually exceed 0·0005 in.

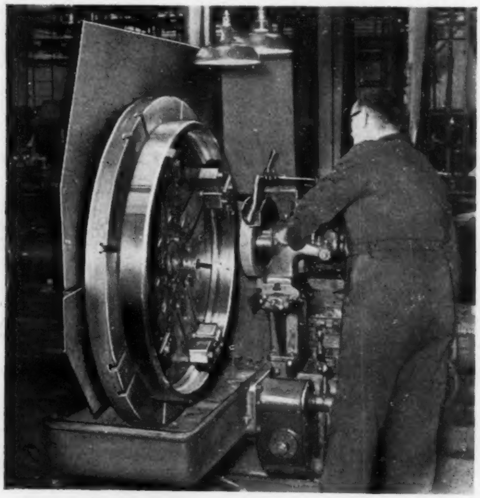

Fig. 13. Grinding a 41-in. Diameter Angular Contact Outer Race, on a Churchill 48-in. Machine

As at the machining stage, the work is located in stepped jaws and clamped axially, in order to minimize distortion, and the locating faces of the jaws are ground in position on the faceplate. A variety of different wheels is employed, for roughing and finishing operations on external and internal surfaces. The wheels for internal grinding are of 9 in. diameter, and are run at a surface speed of 4,000 ft. per min., whereas those for external grinding are of 12 in. diameter, and are run at a speed of 6,000 ft. per min. Rough internal grinding is performed with Universal grade A 46 L5 wheels, and finish internal grinding with wheels of Hoffmann manufacture. The latter are of the alumina type, grade 60 LM. Carborundum grade BA 463 Aloxite wheels are employed both for rough and finish grinding on the external surfaces. For grinding the external surface, the work is run at 14 r.p.m., and for the internal surfaces, at 20 r.p.m. The wheel spindle is driven by a variable-speed D.C. motor, and a typical total metal removal on a component of this size is 0·06 in. on diameter.

Some further examples of the company's production methods will be described in a later article.

AN ELECTRONIC CLOCK which does not need to be connected to the electric power supply has been developed by the General Electric Co., U.S.A. Stray magnetic fields from the supply mains are picked up by an aerial in the clock, and the induced 60-cycle voltage produced is amplified and fed into a transistor oscillator. The oscillator is designed to have a stable frequency as close as possible to 60 c.p.s., and becomes synchronized with the mains frequency. It is used to control a miniature synchronous motor that drives the clock mechanism. This motor is powered by two mercury cells which have a working life of 18 months. In the event of a power failure, the clock will run for several hours without loss of timekeeping accuracy.

Tightening and Tensile Tests on Joints Assembled with Bolts Threaded BSW, BSF, UNC and UNF

By J. E. FIELD*

Owing to thread stripping failures encountered, under service conditions, with the Unified Fine (UNF) threads, where British Standard Fine (BSF) threads had previously been found satisfactory, it was decided to compare the static strengths of these two types of thread, also of Unified Coarse (UNC) and British Standard Whitworth (BSW) threads, under conditions similar to those found in practice. The fatigue strength of a bolt of given nominal thread form is not much affected by the thread pitch, as has been shown experimentally[1], and, as follows from the theoretical analysis[2], increased thread load concentration for fine threads tends to be balanced by the corresponding increase in core area of the bolt.

The static tests were carried out on commercial high-tensile bolts (Code R) and appropriate nuts (Code P), subjected to various degrees of tightening when employed as the clamping members of a steel joint.

It is recommended in the British Standards for Precision Hexagon Bolts, Screws, Nuts and Plain Washers, No. 1083:1951 (Whitworth) and 1768:1951 (Unified), that Code R bolts (45/55 tons per sq. in.) should be used with Code A nuts (28 tons per sq. in. minimum, Brinell Hardness Number 120/235 approximately). In these tests, Code P nuts (35/48 tons per sq. in., Brinell Hardness Number 152/235 approximately) were used, in order to narrow the range of variation of nut hardness, and because it was thought, on the basis of previous experience, that nuts near the bottom of the Code A hardness range would be too soft to develop the full strength of Code R bolts, for all types of thread.

Class 2 (Unified) and the corresponding Medium Fit (Whitworth) bolts and nuts were used, these being the classes of fit normally employed in high-grade engineering work. Since it has been found[3] that increase of effective diameter clearance causes a serious decrease of thread stripping strength, any deficiencies of fine threads in this respect would be even more pronounced with Class 1 or Free Fit threads.

The sizes chosen were $\frac{3}{8}$ in., $\frac{3}{4}$ in. and $1\frac{1}{2}$ in., increasing by a factor of 2. The diameter/pitch (D/p) ratio increases fairly regularly with size for all four types of thread, up to $1\frac{1}{2}$ in., except for UNF, where the pitch is constant at $\frac{1}{12}$ in. from 1-in. to $1\frac{1}{2}$-in. diameter. For this reason, the D/p ratio for $1\frac{1}{2}$-12 UNF threads is abnormally high (18·0), and it was thought desirable to check the strength of such threads. The D/p ratios for $\frac{3}{8}$-24.UNF and $\frac{3}{4}$-16.UNF (equal to 9·0 and 12·0 respectively) are also on the high side of the mean UNF curve of D/p against diameter, and any tendency to thread stripping would be expected to be rather more pronounced in these than in adjacent sizes.

DESCRIPTION OF BOLTS AND NUTS

All the bolts were Code R (45/55 tons per sq. in.), and all the nuts Ordinary, Code P (35/48 tons per sq. in.), obtained from a commercial stockist. The bolts, including the threads, were covered with a thin adherent black scale, whereas the nuts were bright. Sizes of the bolt heads and of the nuts conformed to the appropriate British Standards (1083:1951 for BSW and BSF, and 1768:1951 for UNC and UNF). All the bolts and nuts were stated to be Class 2 (Unified) or Medium Fit (Whitworth). The threaded lengths of the bolts were about half

TABLE I. BOLT SIZES AND MANUFACTURERS

Nominal size and number of threads per in.	$\frac{D}{p}$	Length of bolt, in.	Symbol representing manufacturer	
			Bolt	Nut
$\frac{3}{8}$-24.UNF	9·0	2	A	F
$\frac{3}{8}$-20.BSF	7·5	2	A	F
$\frac{3}{8}$-16.UNC	6·0	2	B	F
$\frac{3}{8}$-16.BSW	6·0	2	A	F
$\frac{3}{4}$-16.UNF	12·0	3	A	F
$\frac{3}{4}$-12.BSF	9·0	3	D, E*	F
$\frac{3}{4}$-10.UNC	7·5	3	C	F
$\frac{3}{4}$-10.BSW	7·5	3	C	F
$1\frac{1}{2}$-12.UNF	18·0	5	C	F
$1\frac{1}{2}$-8.BSF	12·0	5	C	F
$1\frac{1}{2}$-6.UNC	9·0	5	C	F
$1\frac{1}{2}$-6.BSW	9·0	5	C	F

* The bolts from manufacturer E were used only for repeated tightening tests.

* Mechanics and Materials Division, Mechanical Engineering Research Laboratory, East Kilbride.

[1] All references at end of article.

TABLE 2. SUMMARY OF RESULTS OF TIGHTENING AND TENSILE TESTS ON ⅜-IN. THREADS
(Code R bolts + Code P nuts)

Type of thread	Average hardness of bolts/nuts HD/30	Tightening torque test to failure (no external tensile load)			Tensile test to failure (no pre-tightening)*		Tensile test to failure of joint pre-tightened to 90 per cent of maximum torque (Col. 3)*			
		Yield torque (lb.-in.)	Maximum torque (lb.-in.)	Mode of failure	Maximum load (tons)	Mode of failure	Pre-tightening torque (lb.-in.)	Maximum load (tons)	Mode of failure	Load for joint separation (tons)
	1	2	3	4	5	6	7	8	9	10
⅜-16.BSW	250/220	350 (+70) (−40)	400 (+80) (−40)	B (6)	4·5 (+0·2) (−0·4)	B (6)	360 P (3) + E (3)	4·4 (±0·2)	B (6)	3·7 (+0·3) (−0·6)
⅜-20.BSF	280/200	405 (+15) (−35)	500 (+50) (−40)	B (5) + N (1)	4·6 (±0·2)	B (5) + N (1)	450 P (6)†	4·6 (+0·1) (−0·2)	B (5) + N (1)	3·6 (±0·1)
⅜-16.UNC	230/200	400 (±20)	445 (±30)	B (6)	4·3 (±0·1)	B (6)	405 P (6)	4·2 (±0·1)	B (5) + N (1)	3·1 (+0·4) (−0·6)
⅜-24.UNF	250/200	415 (+35) (−25)	525 (+100) (−125)	B (2) + N (4)	4·5 (+0·2) (−0·9)	N (6)	475 P (6)	4·4 (±0·2)	N (6)	3·7 (±0·6)

* In general, no definite yield was observed in the tensile tests. Two of the hand-tight ¾-10.BSW bolts yielded at 15·5 tons, and three of the hand-tight ¾-10.UNC bolts at 15·7 tons approximately. All the ⅜-in. assemblies (BSW, BSF, UNC and UNF) gave a very indefinite yield at about 4 tons, and the 1½-12 UNF assemblies at about 55 tons (thread bending).
† In addition, two bolts broke during pre-tightening before the torque of 450 lb.-in. was reached.
B—failure across core of threaded portion of bolt, with appreciable necking. No, or only slight, bending of bolt threads.
N—failure by stripping of nut threads, with considerable bending of bolt threads, generally accompanied by slight necking of bolt. Number in brackets indicates number of assemblies which failed in the manner indicated.
P—yield of bolt and/or nut occurred before reaching stated pre-tightening torque. Application of torque continued until latter was reached.
E—stated pre-tightening torque reached without appreciable yielding.
All threads were lubricated with Shell Retinax A, a light grease.

the total shank lengths. The sizes investigated, with symbols representing manufacturers, are listed in Table 1.

METALLOGRAPHIC EXAMINATION

One bolt was selected from each of the 13 types listed in the penultimate column of Table 1. (The ¾-in. BSF bolts were from two manufacturers). An axial section was prepared through the threaded portion of each bolt, and this was polished and etched to reveal the grain structure. The ⅜-in. bolts showed evidence of having been produced by rolling, in that there were seams in some of the thread crests. None of the bolts, however, showed any tendency to "grain flow" following the thread contour, so that, in the bolts investigated, any such effect due to the threads being produced by rolling must have been removed during the heat-treatment normally carried out after rolling, in order to obtain the requisite static tensile strength. (Sometimes only a stress relief treatment is carried out after rolling, and this does not usually remove the "grain flow" completely). No serious decarburization was observed in any bolt. For a given size of bolt, the grain size was similar for all four types. It was rather finer for ⅜-in. bolts than for larger sizes.

There appears, therefore, to have been no significant metallurgical differences betwen the various types of bolt investigated. All the nuts were obtained from a single manufacturer.

HARDNESS TESTS

Standard diamond pyramid hardness tests were carried out on most of the ⅜-in. and ¾-in. bolts and nuts, and on six bolts and six nuts of each type

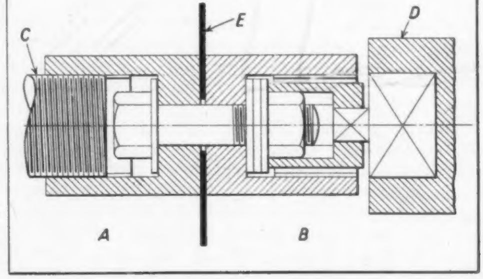

Fig. 1. Method of Testing Bolt and Nut Combinations. *A*. Tensile Test. *B*. Tightening Test. *C*. Tension Rod of Tensile Testing Machine. *D*. Grip of Torsion Testing Machine. *E*. Plate for Detecting Joint Separation

TABLE 3. SUMMARY OF RESULTS OF TIGHTENING AND TENSILE TESTS ON ¾-IN. THREADS
(Code R bolts + Code P nuts)

Type of Thread	Average hardness of Bolts/Nuts HD/30	Tightening torque test to failure (no external tensile load)			Tensile test to failure (no pre-tightening)*		Tensile test to failure of joint pre-tightened to 75 per cent of maximum torque (Col. 2)*				Tensile test to failure of joint pre-tightened to 90 per cent of maximum torque (Col. 3)*			
		Yield torque (lb.-in.)	Maximum torque (lb.-in.)	Mode of failure	Maximum load (tons)	Mode of failure	Pre-tightening torque (lb.-in.)	Maximum load (tons)	Mode of failure	Load for joint separation (tons)	Pre-tightening torque (lb.-in.)	Maximum load (tons)	Mode of failure	Load for joint separation (tons)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
¾-10 BSW	250/200	2,650 (+450) (−400)	3,310 (+310) (−290)	B(6)	17·3 (+0·9) (−0·6)	B(6)	2,480 E(6)	17·2 (+0·9) (−1·0)	B(6)	9·4 (+0·5) (−1·1)	2,980 P(6)	16·8 (+0·7) (−0·5)	B(6)	9·7 (+0·5) (−0·3)
¾-12 BSF	200/200	3,210 (+290) (−310)	4,280 (+440) (−480)	B(6)	18·6 (+1·0) (−1·3)	B(6)	3,210 P(4)+E(2)	17·8 (+1·2) (−1·6)	B(6)	12·0 (+1·0) (−0·7)	3,850 P(6)	18·4 (+1·6) (−0·9)	B(6)	14·0 (+1·5) (−1·3)
¾-10 UNC	260/210	3,420 (+180) (− 60)	4,130 (+210) (−230)	B(6)	17·6 (+0·7) (−0·9)	B(6)	3,100 E(6)	17·5 (±0·6)	B(6)	12·7 (+0·5) (−0·8)	3,715 P(6)	17·4 (+0·6) (−0·9)	B(6)	13·9 (+0·3) (−0·4)
¾-16 UNF	250/200	3,650 (+410) (−1080)	5,080 (+800) (−1060)	B(2) + N(4)	21·1 (+1·1) (−0·6)	B(4) + N(2)	3,810 P(2)+E(4)	20·5 (+0·5) (−0·7)	B(3) + N(3)	17·0 (+1·0) (−0·8)	4,570 P(6)	20·6 (+1·1) (−0·7)	B(2) + N(5)	18·6 (+0·7) (−0·6)

* In general, no definite yield was observed in the tensile tests. Two of the hand-tight ¾-10 BSW bolts yielded at 15·5 tons, and three of the hand-tight ¾—10 UNC bolts at 15·7 tons approximately. All the ¾-in. assemblies (BSW, BSF, UNC and UNF) gave a very indefinite yield at about 4 tons, and the 1½—12 UNF assemblies at about 55 tons (thread bending).
B—failure across core of threaded portion of bolt, with appreciable necking. No, or only slight, bending of bolt threads.
N—failure by stripping of nut threads, with considerable bending of bolt threads, generally accompanied by slight necking of bolt. Number in brackets indicates number of assemblies which failed in the manner indicated.
P—yield of bolt and/or nut occurred before reaching stated pre-tightening torque. Application of torque continued until latter was reached.
E—stated pre-tightening torque reached without appreciable yielding.
All threads were lubricated with Shell Retinax A, a light grease.

in the 1½-in. size. The hardness variations within any particular batch of nuts were not very great, and all the nuts were well within the values quoted in the above-mentioned British Standards for Code P material.

Large variations were often obtained in the hardness numbers for a particular bolt, and the average values for some of the bolts appeared to be below the minimum hardness for Code R material. However, in the tensile tests subsequently carried out, no case was found of a bolt below the minimum value* of 45 tons per sq. in. for Code R. The hardness values are not, therefore, a reliable guide to the strength of the bolts.

Average hardness values obtained are included in Table 2, 3 and 4.

TIGHTENING AND TENSILE TESTS

In the principal series of tests, a bolt and nut were used to fasten together a pair of steel adapters, which could be fitted to the grips of a tensile testing machine for applying external load to the joint (see Fig. 1). Torque could be applied to the combination by means of hexagon sockets fitting over the bolt head and nut and connected to a static torsion testing machine. Six combinations of each type were tested, in each size. Before testing, the threads were brushed to clean off loose matter. This brushing did not disturb the scale on the bolts. The threads and the bearing faces of the nut and underlying washer were then coated with a light grease.

The main group of tests comprised tightening tests to failure, and tensile tests on pre-tightened joints, with a single tightening in each case. For the first test, the nut was tightened continuously on the bolt in a static torsion testing machine, at an approximately constant rotational speed of 90 deg. per min., to determine the yield torque and the maximum torque developed

* Based on "stress area" = π (effective diameter + minor diameter)^2/16.

TABLE 4. SUMMARY OF RESULTS OF TIGHTENING AND TENSILE TESTS ON 1½-IN. THREADS
(Code R bolts + Code P nuts)

Type of thread	Average hardness of bolts/nuts HD/30	Tightening torque test to failure (no external tensile load)			Tensile test to failure (no pre-tightening)*		Tensile test to failure of joint pre-tightened to 75 per cent of maximum torque (Col. 3)*			
		Yield torque (lb.-in.)	Maximum torque (lb.-in.)	Mode of failure	Maximum load (tons)	Mode of failure	Pre-tightening torque (lb.-in.)	Maximum load (tons)	Mode of failure	Load for joint separation (tons)
	1	2	3	4	5	6	7	8	9	10
1½-6.BSW	260/190	21,250 (+2,450) (−1,750)	34,200 (+4,800) (−3,400)	B (6)	72·7 (+3·4) (−2·9)	B (5) + N (1)	25,650 E (6)	70·6 (+5·8) (−3·7)	B (6)	54·9 (+5·8) (−2·9)
1½-8.BSF	240/200	27,420 (+2,980) (−3,020)	46,200 (+3,600) (−3,200)	B (6)	75·1 (+3·3) (−1·8)	N (6)	34,650 E (6)	78·4 (+4·1) (−5·0)	B (3) + N (3)	64·6 (+2·4) (−4·6)
1½-6.UNC	235/210	21,050 (+950) (−550)	38,850 (+1,850) (−2,850)	B (6)	73·0 (±3·4)	B (5) + N (1)	29,150 E (6)	72·2 (+5·05) (−2·8)	B (6)	54·0 (+1·8) (−1·5)
1½-12.UNF	235/200	21,230 (+1,470) (−1,430)	47,300 (+4,700) (−2,700)	N (6)	75·6 (+3·2) (−7·1)	N (6)	35,625 E (6)	75·1 (+3·3) (−3·4)	N (6)	62·15 (+3·35) (−3·65)

* In general, no definite yield was observed in the tensile tests. Two of the hand-tight ¾-10.BSW bolts yielded at 15·5 tons, and three of the hand-tight ¾-10.UNC bolts at 15·7 tons approximately. All the ⅝-in. assemblies (BSW, BSF, UNC and UNF) gave a very indefinite yield at about 4 tons, and the 1½-12 UNF assemblies at about 55 tons (thread bending).

B—failure across core of threaded portion of bolt, with appreciable necking. No, or only slight, bending of bolt threads.

N—failure by stripping of nut threads, with considerable bending of bolt threads, generally accompanied by slight necking of bolt. Number in brackets indicates number of assemblies which failed in the manner indicated.

P—yield of bolt and/or nut occurred before reaching stated pre-tightening torque. Application of torque continued until latter was reached.

E—stated pre-tightening torque reached without appreciable yielding.

All threads were lubricated with Shell Retinax A, a light grease.

before failure. For brevity, the latter is referred to below as "failure torque."

The tensile tests to failure were made on combinations tightened by hand only, and to 75 per cent and 90 per cent of the average failure torque for a particular size and type of thread. For these two conditions, the tensile load to separate the joint was determined, in addition to the maximum load, by noting when a flat plate, interposed between the adapters, just became loose.

It has been shown that tightening to yield develops maximum clamping load and has no adverse effects for coarse threads[4]. On the other hand, it is not desirable to tighten to far above the yield. Thus, for the ⅝-in. size, as the yield, for all types of thread, exceeded 75 per cent of average failure torque, this tightening condition was not investigated. On the other hand, for the 1½-in. size, as the yield was invariably less than 75 per cent of average failure torque, this condition was investigated, and not the one involving a more severe tightening. Both conditions were investigated for the ¾-in. size. The results of the above tests are reported in Tables 2, 3 and 4.

Some similar tightening and tensile tests were carried out on ¾-in. combinations with bored-out nuts, to simulate conditions resulting from the use of an oversize tapping drill. For each type of thread, the nuts were bored out to a minor diameter which, in conjunction with the average measured major diameters of the mating bolts, gave a depth of engagement equal to 50 per cent of the full thread height for a bolt of basic size, as given in B.S. 84/1956 for BSW and BSF, and in B.S. 1580:1953 for UNC and UNF threads. Determinations were made of failure torque, and of tensile loads for joint separation and failure after tightening to 75 per cent of failure torque for normal combinations. The latter type of test was also extended to include joints tightened up to a maximum of seven times. Joint separating loads were determined after each tightening, and tensile load to failure was finally applied. The results of the tests with bored-out nuts are given in Table 6.

A fuller investigation was also made of the effect of repeated tightening on normal combinations in the ¾-in. size.

First, tests involving only seven tightenings were carried out, the nut being tightened on the bolt in a static torsion testing machine until yield occurred. After the sixth tightening, the tensile load for joint separation was determined. The nut was then completely removed to permit inspection of the threads (also after the fifth tightening). Finally, the combination was tightened to failure. The results of these tests are included in Table 5.

As these latter tests showed a tendency for thread bending to occur in the UNF combinations, it was decided to carry out further tests, involving a much greater number of tightenings. Three combinations

TABLE 5. RESULTS OF REPEATED TIGHTENING TESTS ON NORMAL ¾-IN. COMBINATIONS

Combination		Applied torque for successive tightenings (lb.-in.) 1	2	3	4	5	6	7	Joint separating load after 6th tightening (tons)	Maximum failure torque on 7th tightening (lb.-in.)	Damage after† 5th tightening	Damage after† 6th tightening	Mode* of final failure
¾-10 BSW (1)	Yield ... Break-loose ...	3,100 2,100	3,000 1,950	3,000 1,920	2,900 1,800	3,000 1,840	3,300 2,130	3,000 —	13·3	3,120	No thread bending Bolt necked by 0·007 in.	As after 5th tightening	B
(2)	Yield ... Break-loose ...	3,000 2,260	3,200 2,040	2,900 1,960	2,820 1,900	2,860 1,940	3,200 2,360	3,300 —	13·7	3,860	No thread bending Bolt necked by 0·004 in.	As after 5th tightening	B
(3)	Yield ... Break-loose ...	3,150 1,980	2,900 1,900	2,900 1,900	2,900 1,900	2,900 1,900	2,800 1,600	2,600 —	13·9	3,040	No thread bending Bolt necked by 0·004 in.	As after 5th tightening	B
¾-12 BSF (1)	Yield ... Break-loose ...	4,200 3,000	4,000 2,800	4,100 3,000	3,910 2,750	4,300 3,000	4,500 2,900	3,100 —	18·7	3,290	No thread bending Bolt necked by 0·010 in.	As after 5th tightening	B
(2)	Yield ... Break-loose ...	4,700 3,400	4,380 3,200	4,400 3,200	4,300 3,200	4,280 3,200	4,450 3,450	3,150 —	17·6	3,780	No thread bending Bolt necked by 0·010 in.	No thread bending Bolt necked by 0·013 in.	B
(3)	Yield ... Break-loose ...	4,200 3,050	4,200 2,850	4,480 2,750	4,150 2,400	3,700 2,650	3,700 2,550	3,550 —	19·2	3,930	No thread bending Diameter not checked	No thread bending Bolt necked by 0·020 in.	B
¾-10 UNC (1)	Yield ... Break-loose ...	3,050 2,100	2,900 1,800	2,900 1,800	2,900 1,750	2,900 1,750	2,900 1,600	2,800 —	16·0	3,100	No thread bending Bolt necked by 0·009 in.	No thread bending Bolt necked by 0·013 in.	B
(2)	Yield ... Break-loose ...	2,700 1,880	2,740 1,760	2,720 1,740	2,780 1,700	2,740 1,700	2,480 1,350	2,700 —	14·4	2,990	No thread bending Bolt necked by 0·006 in.	No thread bending Bolt necked by 0·008 in.	B
(3)	Yield ... Break-loose ...	2,750 1,750	2,750 1,700	2,800 1,750	2,900 1,700	2,750 1,700	2,650 1,600	2,850 —	14·7	3,120	No thread bending Bolt necked by 0·007 in.	As after 5th tightening	B
¾-16 UNF (1)	Yield ... Break-loose ...	4,000 3,150	4,000 2,700	3,600 2,700	3,600 2,700	3,400 2,500	3,600 2,900	3,700 —	18·2	3,900	Bolt threads slightly bent Bolt necked by 0·009 in.	Bolt threads rather more bent. Bolt necked by 0·009 in.	N
(2)	Yield ... Break-loose ...	3,600 3,100	3,200 2,600	3,200 2,450	3,200 2,450	3,300 2,450	3,250 2,450	3,250 —	18·0	3,690	Bolt threads slightly bent Bolt necked by 0·009 in.	Bolt threads slightly bent. Bolt necked by 0·009 in.	N
(3)	Yield ... Break-loose ...	3,600 2,900	3,230 2,600	3,300 2,600	3,370 2,600	3,500 2,750	3,400 2,700	3,250 —	18·4	3,400	Bolt threads slightly bent Bolt necked by 0·005 in.	Bolt threads slightly bent Bolt necked by 0·006 in.	N

† Nut threads not easy to observe, but probably bent if bolt threads were bent.
* The necking of the bolt at fracture was considerable for BSW, BSF and UNC. The necking of the UNF bolts after stripping failure was only a few thousandths of an inch more after the 6th tightening.
B—failure across core of threaded portion of bolt, with appreciable necking. No, or only slight, bending of bolt threads.
N—failure by stripping of nut threads, with considerable bending of bolt threads, generally accompanied by slight necking of bolt.

of each type were tested. The first was repeatedly tightened to yield until failure occurred. The second and third combinations were repeatedly tightened in the same way, but for a somewhat smaller number of tightenings, after which the tensile loads for joint separation and for failure were determined. In this manner, a check was obtained on the extent of the loss of clamping load due to a large number of tightening. The results of these tests are plotted in Fig. 2-5.

Finally, an attempt was made to obtain similar information for repeated tightening to fixed torque values, again using ¾-in. combinations. As the maximum speed of the torsion testing machine was only ¼ turn per min., the torque was applied in these tests by a limiting-moment torque spanner, the setting of which was continually checked against the torsion testing

TABLE 6. SUMMARY OF RESULTS OF TIGHTENING AND TENSILE TESTS ON ¾-IN. BOLTS ASSEMBLED WITH BORED-OUT NUTS[1]

Type of thread	Tightening torque test to failure (no external tensile load)			Tensile test to failure, of joint pre-tightened once to 75 per cent of maximum torque for normal combinations				Tensile test to failure, of joint pre-tightened 7 times to 75 per cent of maximum torque for normal combinations (Col. 4)			
	Yield torque (lb.-in.)	Maximum torque (lb.-in.)	Mode of failure	Pre-tightening torque (lb.-in.)	Maximum tensile load, (tons)	Mode of failure	Load for joint separation, (tons)	Load for joint separation after 6th tightening (tons)	Load for joint separation after 7th tightening (tons)	Maximum tensile load after 7th tightening (tons)	Mode of failure
	1	2	3	4	5	6	7	8	9	10	11
¾-10.BSW	3,160 (+320) (−220)	3,750 (+240) (−220)	B (3)	2,480 E (6)	16·9 (+1·1) (−0·9)	B (6)	7·9 (+0·4) (−0·6)	8·8 (±0·8)	8·5 (+0·7) (−0·5) (5 results)[2]	17·4 (±0·4) (5 results)[2]	B (6)
¾-12.BSF	3,760 (+470) (−400)	5,180 (+40) (−50)	B (3)	3,210 E (6)	17·2 (+0·5) (−0·8)	B (5) + b (1)	11·1 (+0·6) (−0·9)	12·5 (+0·9) (−0·7)	12·8 (+0·8) (−0·6)	17·2 (+0·7) (−0·6)	B (3) + n (3)
¾-10.UNC	Indefinite	3,640 (+240) (−320)	B (2) + b (1) (severe necking)	3,100 P (4) (+ 2 indefinite)	16·6 (+0·9) (−1·8)	B (5) + b (1)	13·7 (+1·0) (−0·9)	13·2 (+0·8) (−1·2) (4 results)[3]	14·5 (+0·4) (−0·2) (3 results)[3]	16·9 (±0·4) (3 results)[3]	B (5) + b (1)
								Pre-tightening torque = 3,650 lb.-in.[4]			
¾-16.UNF	Indefinite	4,190 (+270) (−240)	N (3)	3,810 (Yield indefinite)	19·3 (+1·0) (−1·5)	n (6)	16·5 (±0·8)	15·2 (±0·5)	15·8 (±0·4) (2 results)[5]	19·0 (+1·3) (−1·4) (2 results)[5]	b (2) + n (1)
								Pre-tightening torque = 3,210 lb.-in.			
								!2·6 (+1·0) (−0·6)	13·5 (+0·6) (−1·2)	18·5 (+0·5) (−0·6)	b (3) (necking very slight)

1—Code R bolts + Code P nuts, both class 2 or medium fit, except that the nut minor diameters were oversize, to give depths of engagement equal to 50 per cent of full thread height of basic size bolts.
2—One bolt broke during 7th tightening.
3—Two bolts failed on 2nd and 6th tightenings respectively, and a third bolt failed on 7th tightening.
4—Of three assemblies tightened to 3,810 lb.-in., two failed by stripping on the 2nd tightening and one at the tensile separating load of 14·5 tons, after the 6th tightening (b).
5—One bolt failed on 7th tightening (b).
B—failure across core of threaded portion of bolt, with marked necking.
N—failure by stripping (bending and shearing) of nut threads, with considerable bending of bolt threads and only slight necking of bolt.
b—failure by stripping of bolt threads. Both nut and bolt threads badly bent. Some necking of bolt.
n—failure by stripping of both bolt and nut threads, with only slight necking of bolt.
For items B, N, b, and n, the number in brackets shows the number of assemblies which failed in the manner indicated.
E—Stated pre-tightening torque reached without appreciable yielding.
P—Yield occurred before reaching stated pre-tightening torque. Application of torque continued until the latter was reached.
It should be noted that 3,650 lb.-in. = average yield torque for normal ¾-16.UNF combinations.
3,210 lb.-in. = average yield torque for normal ¾-12.BSF combinations.

machine. A plain steel block was used in place of the joint adapters, with a plain washer under the nut. The results of these tests are given in Table 7.

The bolt tensile strengths, determined during the main series of tests, were all within the Code R specification values of 45/55 tons per sq. in., and the hardness values of the nuts were all well within the Code P specification values.

VARIABILITY OF RESULTS

It should be observed, at the outset, that although the total number of tests was large, only six tests were, in general, carried out under any particular set of conditions, and that there was considerable variability in the results obtained. It is possible, therefore, that the average values and limits of variation might have been somewhat different from those quoted in the tables, if the tests had covered a larger number of samples. Certain conclusions may still be drawn from the results, as to differences between the types and sizes of thread investigated, but the quoted values should only be taken as a general indication of those likely to be obtained in practice under a particular set of conditions, even if the latter are thought to approximate to those of the present tests.

The limits of variation for the different main

types of test (Tables 2 to 4) covering results on all three sizes, are summarized in Table 8 for each type of thread. Except for the case of pre-tightening to 90 per cent of maximum failure torque in the ⅜-in. size, which is not likely to occur very often in practice, the results for UNC are definitely the most consistent. The results for BSW and UNF were the most inconsistent, and abnormally low values seemed particularly likely to be encountered with UNF. Further reference to the scatter of results is made later in considering particular groups of tests.

MODE OF FAILURE

A definite yield, as indicated by a halt in the rise of load with approximately constant rate of strain, was often observed in the tightening tests, but not in the tensile tests. Even in the tightening tests, the onset of yield was generally ill-defined, and tended to be masked by the stick-slip movement of the threads. Quoted values of yield torque are those for which definite yield occurred.

The BSW and UNC combination in all three sizes, and the BSF combination in the ⅜-in. and ¾-in. sizes, generally failed by breakage across the core of the bolt. Many of the UNF combinations in the smaller sizes, and all in the 1½-in. size, failed by stripping of the nut threads, with severe bending of the bolt threads. These differences may be largely explained, as in the Appendix, on a basis of pitch and diameter and of certain other factors. It may be mentioned here that the relatively low height of the 1½-in. Unified nuts, as compared with that of the 1½-in. Whitworth nuts, increased the tendency to stripping failure of UNF combinations, already most pronounced in the larger sizes.

The stripping failures took place more gradually than the bolt core failures, and for a given rate of strain, the torque or tensile load fell off more gradually when stripping occurred. It follows that severe over-tightening might occur during assembly without being detected, for those combinations susceptible to failure by thread stripping—the UNF combinations.

DEVELOPMENT OF CLAMPING LOAD

It will be seen from Tables 2 to 4 that the joint separation loads (indicated in Col. 10 and Col. 14 in Table 3), after a single pre-tightening to a given percentage of maximum failure torque, were not lower for the UNF than for the other types of combination. The same should apply to the initial clamping loads developed on tightening, since

$$P_i / P_s = K_M / (K_M + K_B)$$

where P_i = initial clamping load.
P_s = joint separating load.
K_M = stiffness of clamped members (load per unit deflection).
K_B = stiffness of bolt (load per unit deflection).

The same joint adapters were used throughout, for a given size of bolt, and K_B would not vary much as between the different types of bolt in a given size. An indication of the efficiency of an assembly in developing clamping load may thus be obtained by dividing the torque applied by the load for joint separation (Col. 7 / Col. 10 and Co. 11 / Col. 14 in Table 3). Assemblies with the higher values of torque per ton of separating load will be the least efficient. In this respect, no type of combination shows up consistently better than the others over the whole range of sizes. This result is not surprising, in view of the fact that only about 10 per cent of the total applied torque is effective in producing tensile load in the bolt. The remainder is used, in roughly equal amounts, in overcoming the friction in the threads and at the nut bearing

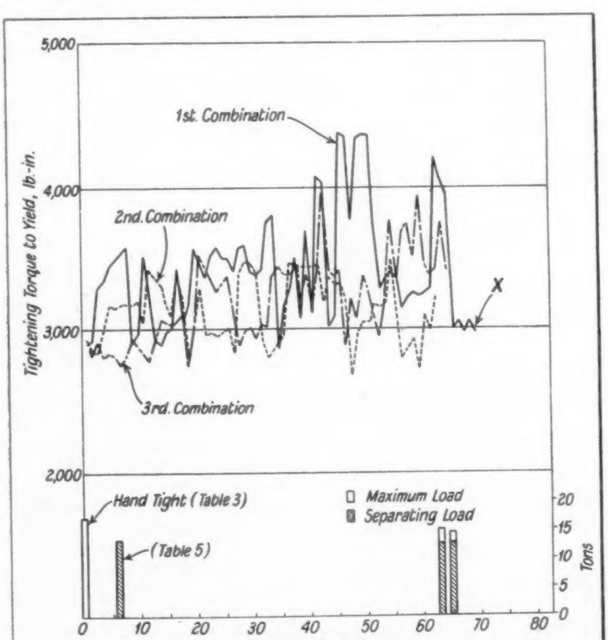

Fig. 2. Results of Repeated Tightening Tests to Yield on ¾-10 B.S.W. Combinations (Group 6). All Failures Occurred Across Core of Bolt. X—Broke on 70th Tightening

TABLE 7. REPEATED TIGHTENING TESTS ON NORMAL ¾-IN. COMBINATIONS, USING A TORQUE SPANNER

Type of combination	Tightening torque, (lb.-in.)	1st Combination			2nd Combination			3rd Combination		
		No. of tightenings	Necking of bolt, (in.)	Other damage to combination	No. of tightenings	Necking of bolt, (in.)	Other damage to combination	No. of tightenings	Necking of bolt, (in.)	Other damage to combination
¾-10.BSW ...	2,500	50 51	0·031 —	None Bolt core failure	70 80 150	0·023 0·024 0·024	None ,, ,,	40 120 160	0·023 0·023 0·024	None ,, ,,
	2,750	20 150	0·0005 0·0005	None ,,	60 150	0·0005 0·001	None ,,			
	3,000	50 150	0·001 0·0015	None ,,	50 150	0·003 0·004	None ,,			
	3,250	50 150	0·007 0·007	None ,,	50 150	0·002 0·0025	None ,,			
	3,500	50 150 250	0·013 0·040 0·060	None ,, ,,	50 100 150	0·008 0·008 0·010	None ,, ,,	20 50 150	0·011 0·014 0·015	None ,, ,,
¾-12.BSF ...	3,000	60 120 240	0·0005 0·004 0·006	None ,, ,,	100 150 200	0·0005 0·0005 0·0005	None ,, ,,			
	3,250	150	0·002	None	100 240 360	0·016 0·051 0·071	None ,, ,,	50 100 150	0·001 0·001 0·002	None ,, ,,
¾-10.UNC ...	3,000	20 180 240	0·012 0·027 0·028	None ,, ,,	150 200	0 0	None ,,			
	3,250	7	—	Bolt core failure	50 100 150	0·043 0·047 0·047	None ,, ,,	50 80	0·016 —	None Bolt core failure
¾-16.UNF ...	3,000	60 160	— 0·0005	None ,,	40 150	0·001 0·001	None ,,			
	3,250	40 80 87	0·0005 0·0005 0·0005	Bolt threads slightly bent Bolt threads more bent Thread stripping failure	30 60 70 90 148	0·003 0·004 0·0045 0·005 0·005	Bolt threads slightly bent Bolt threads slightly bent Bolt threads more bent Bolt threads more bent Thread stripping failure			
	3,500	10 20	0·011 0·011	Not inspected Thread stripping failure	15 18 19	0·014 0·014 0·014	Bolt threads slightly bent Bolt threads more bent Thread stripping failure			

Note.—Where the bolt threads were bent, it is probable that the nut threads were also bent. Observation of the threads inside the nut was difficult.

face[5]. Variations in these frictional forces will thus tend to mask those due to differences in thread form and pitch. Heavy thread deformation occurring prior to failure by stripping may cause the thread friction to increase rapidly, and maximum failure torque would then not be a reliable guide to the clamping load developed.

An attempt was made, by making measurements of bolt elongation under given loads, and when tightened under a given torque, to estimate the stiffness of the joint adapters and the actual clamping loads developed. The results, however, were not very consistent. It appeared that, for the ¾-in. combinations, a joint separating load of 10 tons indicated an initial clamping load of about 8 tons. An interesting secondary result which emerged from measurements made in this connection was that, for these 3-in. long, ¾-in. diameter combinations, the deflection of the bearing face of the nut, relative to the bolt at that point, was of the same order as the elongation of the bolt itself. Consequently, in assessing the effective stiffness of a bolt, the nut deflection should be taken into account.

TENSILE FAILURE LOADS

The loads for tensile failure were not significantly affected by pre-tightening. This result was to be expected, as the assembled joint separated before

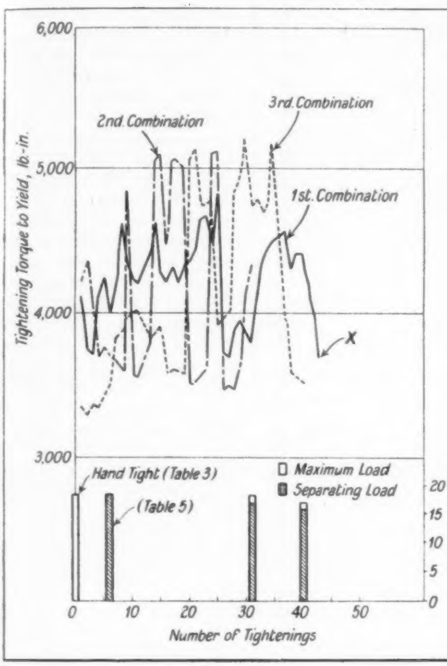

Fig. 3. Results of Repeated Tightening Tests to Yield on ¾-12 B.S.F. Combinations (Group 6). All Failures Occurred Across Core of Bolt. X—Broke on 43rd Tightening

failure in all cases, and any frictional torque would have been released by slight rotation of the joint adapters in the tensile testing machine. For a single pre-tightening, the tensile loads for failure of the UNF combinations compared favourably with those for the other types (Tables 2 to 4, Col. 8, and Table 3, Col. 12).

YIELD AND FAILURE TORQUES

The ratio of yield torque to failure torque was lowest for UNF in all three sizes (Col. 2/Col. 3). For the ⅜-in. and ¾-in. sizes, this ratio decreased over the four types in the following order: UNC, BSW, BSF, UNF. For a given type of combination, the ratio decreased as the size increased, *i.e.*, for the cases investigated, as the D/p ratio increased. Some engineering handbooks give tables of failure torques as a guide to " safe " tightening torques for various kinds of combination. The results show that it is not possible to specify a fixed " safe " percentage of failure torque for all types of combination, or even for different sizes of any one type, without being unduly conservative in the case of relatively coarse threads (low D/p ratio).

REPEATED TIGHTENING TESTS ON NORMAL COMBINATIONS

The results of Table 5 on ¾-in. combinations have been reported in detail to indicate the variations which can be obtained for successive tightenings of the same assembly. It will be seen that the " break-loose " torque (maximum unscrewing value) in all instances, and the tightening yield torque in about half the cases, decreased markedly after the first tightening, but did not undergo a further definite decrease on subsequent tightenings. There was sometimes a marked change after dismantling and reassembling for the sixth to seventh tightenings, but this change was not in the same direction in every instance. The average yield torque after the first, and after the sixth tightening, both differed appreciably from that after a single tightening as given in Table 3. These observations have an obvious relevance to the use of " standard " torque-tension relations in practice.

By comparing Table 5 with Table 3, Col. 10,

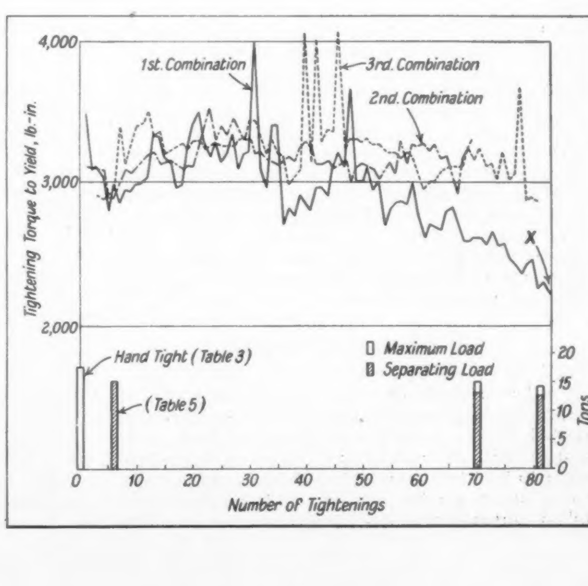

Fig. 4. Results of Repeated Tightening Tests to Yield on ¾-10 U.N.C. Combinations (Group 6). All Failures Occurred Across Core of Bolt. X—Broke on 83rd Tightening

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TABLE 8. LIMITS OF VARIATION OF RESULTS OF TIGHTENING AND TENSILE TESTS IN ALL THREE SIZES

	Maximum percentage variations from mean value of:				
	Yield torque	Maximum failure torque	Tensile failure load	Tensile load for joint separation after pre-tightening to 75 per cent of maximum failure torque	Tensile load for joint separation after pre-tightening to 90 per cent of maximum failure torque
BSW	+20 −15	+20 −10	+5 −9	+9 −12	+8 −16
BSF	±11	+10 −11	+5 −7	+8 −7	+11 −9
UNC	±5	±7	±5	+4 −6	+13 −19
UNF	+11 −30	+19 −24	+5 −20	±6	±16

it can be seen that the joint separating loads after the sixth tightening were invariably markedly higher than those after a single tightening. These higher values were, no doubt, partly or wholly due to decrease of friction owing to repeated rubbing down of high-spots, with the result that a greater proportion of the applied torque was available to develop clamping load. Some of the increase in separating load may have been due, in the BSW and BSF cases, to increase of tightening torque applied, but for UNC and UNF, the torques applied for the sixth tightening in Table 5 were actually lower than those for a single tightening (Table 3, Col. 7) although they resulted in higher separating loads than in the latter case. As the most marked change in yield and break-loose torques occurred after the first tightening, it seemed that the same might apply to joint separating load. A few tests were carried out on ¾-12.BSF assemblies to check this point. Three combinations were each tightened twice, to the average value of yield torque, as given in Table 3, Col. 2 (3,210 lb.-in.), the joint separating load being determined after each tightening. One of the combinations yielded before the tightening torque was reached and two did not. The average joint separating load after the first tightening was 11·2 tons, and the increases of separating load after the second tightening were 0·7, 0·7 and 0·8 ton. These relatively small increases indicate that the joint separating load increases only gradually after each tightening, and not mainly on the second tightening, when a given torque is applied to the nut.

EFFECT OF MULTIPLE TIGHTENING

In order to check the effect on clamping load of a relatively large number of tightenings, the tests reported in Fig. 2 to 5 were carried out on three combinations of each type, using a procedure similar to that followed for the Table 5 tests, except that a much greater number of tightenings was applied—in each case until the occurrence of yield, *i.e.*, of appreciable plastic deformation. It is evident that the number of tightenings to yield, which could be withstood before failure, decreased with the pitch of thread. The 10 t.p.i. threads (UNC and BSW) required about the same torques up to about 50 tightenings, after which the torques for UNC were somewhat lower than for BSW, although the clamping loads were as high, and the number of tightenings to failure greater, than for BSW. This difference in behaviour was similar to that observed in the Table 5 tests.

The BSF combinations withstood only about half, and the UNF combinations only about one

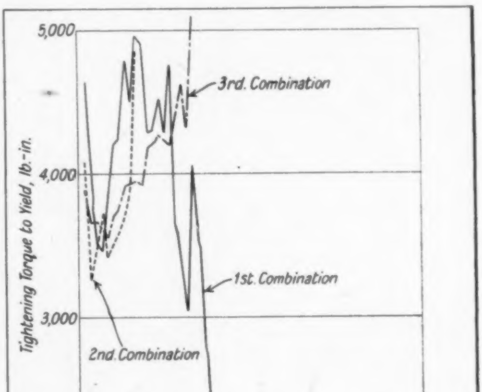

Fig. 5. Results of Repeated Tightening Tests to Yield on ¾-16 U.N.F. Combinations (Group 6). All Failures by Thread Stripping

quarter, of the number of tightenings sustained by the UNC combinations, though the clamping loads developed were higher, corresponding to the higher yield torques.

Within about five tightenings from ultimate failure, there was no very serious reduction in the tensile loads for joint separation and failure for UNC, BSW and BSF. For UNF, it appears that a rapid reduction, corresponding to progressive thread bending, set in by about the 20th tightening, *i.e.*, at about 10 tightenings before the final one, at which thread stripping was not complete, slight clamping still being obtained. This result, again, illustrates the possibility of severe damage to a UNF combination through over-tightening, which might go undetected on assembly.

MULTIPLE TIGHTENING TESTS TO GIVEN TORQUE VALUES

The results of the repeated tightening tests on normal combinations, using a torque spanner, are given in Table 7. Each combination was repeatedly tightened to a given value of torque, instead of to yield, as in the Table 5 tests. The results for ¾-10.BSW at 2,500 lb.-in. tightening torque are anomalous, the damage to the bolt being similar to that produced by a tightening torque of 3,500 lb.-in., and greater than that for intermediate torques. It can only be assumed either that the torque spanner was not applying correct torques, or that the frictional resistance was abnormally low in these tests. They were, in fact, made at a different time from the other tests on BSW combinations, although under ostensibly the same conditions. The results are included further to emphasize the uncertainty which attaches to the use of torque-tension relations. It seems unlikely that the yield torque for these BSW combinations was below 3,000 lb.-in., which agrees approximately with the values in Table 5, but is markedly higher than the value in Table 3.

Considering the remainder of the results, *i.e.*, not including those for ¾-10.BSW at a nominal tightening torque of 2,500 lb.-in., there is still seen to be considerable variability, but certain broad conclusions may be drawn.

At a tightening torque of 3,000 lb.-in., all four types of combination could be tightened 150 times without serious damage. Some of the bolts with coarser threads, and therefore lower core area, had, at this stage, necked down by a few thousandths of an inch, representing only a few per cent loss of load-bearing area. No appreciable thread bending occurred in any of the bolts.

At a tightening torque of 3,250 lb.-in., the ¾-10.UNC combinations were liable to suffer severe necking and core failure of the bolt after relatively few tightenings. The ¾-10.BSW and ¾-12.BSF combinations suffered a small reduction of bolt diameter after 150 tightenings, but could evidently have withstood many more tightenings without failure. In the ¾-16.UNF combinations, bolt necking was slight, but progressive thread bending set in at an early stage, and stripping failure occurred before reaching 150 tightenings. It is evident that serious thread damage could be caused to UNF combinations on assembly, which could not be detected by a change of resistance to tightening. Such damage might not be noticed on dismantling, especially if the threads were coated with grease. Replacement of a damaged bolt in a different nut or tapped hole, in which the threads did not match with the distorted bolt threads, would increase the damage.

At a tightening torque of 3,500 lb.-in. the ¾-10.BSW combinations behaved surprisingly well, and no failure occurred, although bolt necking in one case was quite pronounced. The ¾-16.UNF combinations withstood only a few tightenings at this torque before failure occurred by thread bending and stripping. The ¾-10.UNC combinations would evidently not have withstood this torque satisfactorily, and it seems likely that the ¾-12.BSF would have behaved similarly to the ¾-10.BSW, judging from the results at lower torques.

It should be emphasized, however, that the higher torques withstood by the Whitworth combinations were not necessarily associated with higher clamping loads. The contrary was, in fact, indicated by the Table 5 tests.

For reasons already mentioned, it does not seem wise to place much reliance on the torque values, and the main conclusion from these torque spanner tests is that the ¾-16.UNF combinations were liable to fail, by thread stripping, after relatively few tightenings to a torque appreciably less than the average yield torque, as determined from tests involving one, or only a small number of tightenings (see Tables 3 and 5).

It is usual for the nut to be somewhat softer than the bolt, and yield in bending will occur in the nut threads at least as soon as in the bolt threads. Removal of a nut after such bending had occurred would involve forcing the bent nut threads over undeformed threads near the free end of the bolt; this would cause further damage to the nut threads. Although the average value of bending stress at the thread roots does not depend on pitch/diameter ratio, its maximum value is greater for fine than for coarse threads, owing to the greater concentration, with the former, of the thread load towards the bearing face of the nut[2]. Fine threads would, therefore, yield at a lower applied load than coarse threads, and this fact, in view of the thread deformation factor noted above, may partly account for the comparatively low resistance of fine threads to repeated heavy tightening.

EFFECT OF REDUCING DEPTH OF ENGAGEMENT OF THREADS

The tests with bored-out nuts were carried out because oversize tapping drills are sometimes used in order to facilitate tapping, especially in difficult materials. Results are given in Table 6, and may be compared with those of Table 3, for normal depths of engagement.

Differences in failure torques, Table 3, Col. 3. and Table 6, Col. 2, could be due to differences in thread friction, or to differences in strength, or to both these factors. The higher yield and failure torques for the BSW and BSF combinations with bored-out nuts, as compared with normal combinations of these types, were very probably due to increased thread friction. These combinations all suffered core failure of the bolt, outside the nut, and extra torsional stresses due to increased friction could only have reduced the tensile load for failure (developed by tightening). Confirmation is afforded by the fact that, on boring out the nuts, there was, for BSW and BSF, an increase in the torque required per ton of separating load (for a single tightening to 75 per cent of failure torque for normal combinations: Table 6. Col. 4/Col. 7, as compared with Table 3, Col. 10). The torque per ton of separating load was only slightly increased for UNF, and definitely decreased for UNC. It is probable, therefore, that the low failure torque for the UNC combinations with bored-out nuts was largely due to a decrease in thread friction as compared with that which was present with normal combinations.

That there was a decrease for UNC and not for BSW is difficult to explain, but it will be remembered that the repeated tightening tests on normal combinations (Table 5 and Fig. 2-5) gave indications of lower thread friction for UNC than for Whitworth threads. The tensile failure loads for the combinations with bored-out nuts (Table 6. Col. 5) were somewhat lower than for the normal combinations, but the difference is only sufficient partly to explain the lower maximum failure torque for UNC.

As already implied, on boring out the nuts, there was a small decrease of joint separating load for a given degree of tightening, in all cases except for UNC, for which there was an 8 per cent increase. On the other hand, the separating load after the sixth and seventh tightenings (Table 6, Col. 8 and 9) showed a definite increase over that after the first tightening for BSW and BSF, but not for UNC, although the latter still required the highest separating load after the seventh tightening. The UNF combinations could not withstand even a few tightenings to 75 per cent of failure torque for normal UNF combinations, and the tightening torque had to be reduced to below 3,650 lb.-in. (the average torque for yield of normal UNF combination) before failure was completely avoided on the seventh tightening. At a tightening torque of 3,210 lb.-in., however, which was the highest 75 per cent value for any of the other types of combinations (*viz.* for BSF), seven tightenings could be successfully applied, and the tensile separating load was then rather higher than for BSF, tightened to the same torque, but lower than for UNC combinations, which were only tightened to 3,100 lb.-in.

The stripping failures of the UNF combinations with bored-out nuts generally involved shearing of the bolt threads rather than of the nut threads, and the bending and distortion of both nut and bolt threads was always very severe.

These tests, again, show the poor resistance to repeated tightening of the UNF combinations, compared with the other types. Boring out the nuts emphasized this difference in behaviour, and, with such reduction of depth of engagement, there would appear to be no advantage, with respect to clamping load developed after only a few tightenings, in using UNF in preference to BSF or UNC combinations.

NUMBER OF TURNS OF NUT

During the course of this investigation, numerous observations were made of the number of turns of the nut, relative to the bolt, required to develop various degrees of tightening, including tightening to yield and failure. The number of turns depends to some extent on the length of bolt and stiffness of the joint, but these factors are not as important as might at first appear, due to bolt elongation being concentrated in the threaded portion, and to the relatively high stiffness of most load-bearing joints. There was, however, considerable variation in the observed values, and often a marked decrease, after the first tightening, in the amount of turning of the nut to produce a given tightening torque. This decrease was no doubt due to flattening of high-spots on the bearing surfaces, with a consequent change in the datum (hand-tight) position of the nut.

The following broad conclusions could be drawn. After a preliminary tightening and unscrewing to obtain a proper seating, half a turn of the nut from the hand-tight position would generaly be sufficient slightly to exceed the yield for the BSW, BSF and UNC combinations in all three sizes. A few cases were encountered of BSF combinations in the ¾-in. size, for which yield was not quite reached. The amount of turning for failure was always more than one turn, ranging up to 1⅔ turns for ⅜-in. diameter and up to 2½ turns for 1½-in. diameter. For BSW, BSF and UNC combinations, therefore, a preliminary tightening to a little below yield, followed by the application of half a turn of the nut from the hand-tight position, should develop satisfactory clamping in circumstances where more accurate methods of tightening are not available. The preliminary tightening would be especially important where the bearing surfaces were coated with rust or dirt.

For UNF combinations, on the other hand, such a method is not recommended, as it is undesirable to tighten them to yield, which occurs due to thread bending. Half a turn of the nut would not exceed the yield for ¾-in. and 1½-in. UNF combinations, although it might slightly exceed it for ⅜-in. UNF. It could thus be taken as a safe amount for UNF in sizes above ⅜-in., if it was not required to develop maximum safe clamping load in the larger sizes by more accurate means.

This method would not, of course, be suitable for joints incorporating soft gaskets or other flexible parts.

CONCLUSIONS

1. The BSW and UNC combinations in all three sizes, and the BSF combinations in the ⅜-in. and ¾-in. sizes, generally failed by breakage across the core of the bolt, with pronounced necking. Many of the UNF combinations in the smaller sizes, and all in the 1½-in. size, failed by stripping of the nut threads, with severe bending of the bolt threads. The latter mode of failure occurs gradually, during a single tightening if sufficiently severe, and during a relatively small number of tightenings if yielding of the threads in bending occurs. Severe over-tightening might thus be applied and not detected on assembly, possibly with serious consequences when service loads were imposed.

2. For a single pre-tightening, the clamping loads developed, as indicated by joint separating load, and the maximum tensile loads for failure, were not lower for the UNF than for the other assemblies, for all degrees of tightening employed, in all three sizes.

3. ¾-16.UNF combinations satisfactorily withstood repeated assembly, if they were not tightened up to yield, which occurred at higher torques than for the other types. If these ¾-16.UNF combinations were repeatedly tightened up to yield, progressive thread bending led to failure after a smaller number of tightenings than for the other types of combinations. Under these conditions, the number of tightenings withstood increased with the pitch of the thread. Where tightening is controlled, as by proper use of a well-designed torque-spanner, UNF combinations could be used to develop clamping loads about as high as for the other types of combination, even on repeated assembly, at least under laboratory conditions. The need for close control suggests, however, that the coarser threads would be more suitable for general service conditions.

4. In the ⅜-in. and ¾-in. sizes, the ratios of yield torque to failure torque for the four types of combination were in the following descending order of magnitude: UNC, BSW, BSF, UNF. The ratio was also smallest for UNF in the 1½-in. size. For a given type of combination, the ratio decreased with increase of size, *i.e.* with increase of diameter/pitch ratio.

It is not possible, therefore, to specify a fixed "safe" percentage of failure torque for all types of combination, or even for different sizes of one type, without being unduly conservative in the case of coarse threads, having low diameter/pitch ratios.

5. Taking the results of the main series of tightening and tensile tests for the three sizes as a whole, those for UNC were the most consistent, the maximum variations from mean values never exceeding ± 7 per cent, except in a single instance of pre-tightening to well above yield, which would normally be avoided in practice. The results for UNF and BSF were the most inconsistent, those for UNF particularly showing deviations of as much as 30 per cent below the mean value. The chances of encountering an abnormally weak combination thus appear to be greatest for UNF.

6. Unified nut heights, for threads over 1-in. diameter, are calculated according to formulae given in B.S. 1768:1951, Appendix C, p. 28. The values so obtained are less than the corresponding values for Whitworth nuts, tabulated in B.S. 1083:1951, p. 21, for threads up to 2-in. diameter. Since failure of the 1½-12.UNF combinations invariably occurred by stripping, it would appear desirable to increase the height (length of engagement) of Unified nuts, for threads over 1-in. diameter, to that of Whitworth nuts.

For similar reasons, it is suggested that, for UNF in all sizes, and for BSF in larger sizes (say over 1 in.), nuts for Code R bolts should be Code P and not Code A, as at present recommended in B.S. 1083 and 1768.

7. Reduction of the depth of engagement to about 50 per cent of basic, by boring out the nut, reduced the resistance to repeated tightening, especially of UNF combinations. Clamping loads for a small number of tightenings were not seriously affected, except that the UNF combinations were unable to withstand tightening torques as high as for normal UNF combinations, and thus could not develop such high clamping loads. Use of an oversize tapping drill is thus to be discouraged for UNF threads.

8. As a rough guide under field conditions, for stiff metal-to-metal joints, the nut should be first well tightened (say to somewhat below yield of the combination), then unscrewed and re-tightened half a turn from the new finger-tight position.

9. Hardness tests on the surface of the finished bolt are of little value for checking the quality of Code R bolts.

RECOMMENDATION

Where heavy loads must be transmitted, it is advisable to avoid the use of UNF threads unless tightening can be closely controlled, or unless their use is desirable for reasons other than those of strength. If such close control is possible, yielding of UNF threads, which occurs mainly by bending, should be avoided. It should be borne in mind that loss of fit due to wear, corrosion, and similar factors is epecially serious in the case of fine threads.

The deficiency of UNF threads implied in this suggestion is due not to the form of thread, but to the fineness of this particular series. UNF was never intended as an automatic replacement for BSF. The coarse UNC series should be adequate for most purposes.

ACKNOWLEDGEMENTS

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Board, and this article is published by permission of the Director of Mechanical Engineering Research.

APPENDIX: REASONS FOR DIFFERENT MODES OF FAILURE

As stated under "Mode of failure," the BSW and UNC combinations in all three sizes, and the BSF combinations in the ⅜-in. and ¾-in. sizes, generally failed by breakage across the core of the bolt. Many of the UNF combinations in the smaller sizes, and all in the 1½-in. size, failed by stripping of the nut threads, with severe bending of the bolt threads. These differences may be qualitatively explained as follows.

Shear failure tends to occur at a diameter which is less than the major thread diameter by a small amount, proportional to the pitch, say at a diameter $D-ap$, where D = major diameter, p = pitch, and a = constant, for a given form of thread (there would not, in fact, be much difference between Unified and Whitworth threads). In other words, shear is assumed to occur at a distance below the major diameter equal to a given proportion of thread depth, which is itself proportional to pitch. The diameter of the cross-sectional area on which it is appropriate to base the tensile failure load (empirically found to be about the mean of the minor and effective diameters) is similarly equal to $D-bp$, where b = constant (b is greater than a). Now the tensile failure area is proportional to $(D-bp)^2$, and the shear failure area to $(D-ap)L$, where L is length of engagement, *i.e.* height of nut. The ratio T/S of tensile to shear failure load will therefore be proportional to:—

$$(D-bp)^2/(D-ap)L \text{ or to } (D-bp)^2/(D-ap)D$$

since nut height L is approximately proportional to nominal diameter D. Approximately, therefore,

$$T/S \propto 1-2bp/D+ap/D \propto 1-p/D(2b-a)$$

since $a < b < 1$ and $p \ll D$.

For a given nominal size D, the T/S ratio will increase as the pitch decreases, and shear failure will become more likely. Thus, the UNF threads generally failed by stripping, whilst the coarser threads failed in tension across the core of the bolt.

Again, as size increases, the T/S ratio will increase as the p/D ratio decreases. This explains why the BSF threads failed by stripping in the 1½-in. size but not in the smaller sizes.

It must also be noted that the nut heights were not, in fact, constant for a given size of thread. The specification values and the L/D ratios are given in Table 9.

As required by the specifications, there was, for each size, a difference of a few per cent between the height of the BSW and BSF nuts on the one hand, and that of the UNC and UNF nuts on the other. The Whitworth nuts were thicker than the Unified in the ¾-in. and 1½-in. sizes, but thinner than the Unified in the ⅜-in. size. As the stripping strength of a combination is proportional to the nut height[6], these differences probably explain the occasional stripping failures with ⅜-20.BSF combinations. They would also, of course, tend to increase the probability of stripping failure in the Unified combinations in the larger sizes. This is not important for UNC, but rather unfortunate in respect of UNF.

In the 1½-8.BSF case, all the combinations tightened to failure suffered breakage of the bolt, whilst those subjected to tensile load only failed by stripping of the threads. Similarly, there seemed to be a greater tendency to stripping failure in a pure tensile test for ⅜-24.UNF. This result may be due to the tightening failures occurring under conditions of combined tensile clamping load and frictional torque, although it is difficult to explain why other combinations did not behave similarly, *e.g.* ¾-16.UNF.

Yet another factor involved in the stripping strength of a combination is the reduction caused by increase of effective diameter clearance between the external and internal threads[3]. Any factors tending, in effect, to increase this clearance, will probably tend to do so by an amount independent of the fineness of the thread, *e.g.* standard bolt diametral tolerances are a greater proportion of thread depth for fine than for coarse threads. Again, wear, corrosion and decarburization effects will tend to affect a certain depth of material which will be proportionately greater for fine than for coarse threads. Such factors might be important under some conditions of service. A further factor causing loss of diametral fit is the expansion of the nut under load. This expansion varies from

(*Continued on p.* 1425)

TABLE 9. SPECIFICATION MAXIMUM VALUES OF NUT HEIGHT, AND L/D RATIOS

Size, in.	Whitworth		Unified	
	Nut height, in.	Nut height / Nom. diameter	Nut height, in.	Nut height / Nom. diameter
⅜	0·312	0·83	0·33	0·88
¾	0·687	0·92	0·66	0·88
1½	1·375	0·92	1·28*	0·85

* Calculated from formula given in B.S. 1768, Appendix C, page 28

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East German Machine Tools at the Leipzig Fair

In MACHINERY, 92/1268—30/5/58 reference was made to some East German machine tool exhibits at this year's Leipzig Fair, and others are considered in the following pages, also some examples of induction heating equipment.

CIRCULAR-DIE THREAD ROLLING MACHINES

The type GAWR16, fully-automatic, circular-die, thread rolling machine, shown in Fig. 1, is a new development by VEB Werkzengmaschinenfabrik Bad Duben. It is of the type in which the workpieces are fed from a magazine into an indexing carrier surrounding one of the rolls. The thread rolls operate at fixed centres, and are eccentrically-mounted so that a piece is threaded in slightly less than one revolution. During the idle part of the roll revolution, the carrier is indexed to bring a fresh blank to the rolling position, and the finished piece falls out of the carrier into a container beneath.

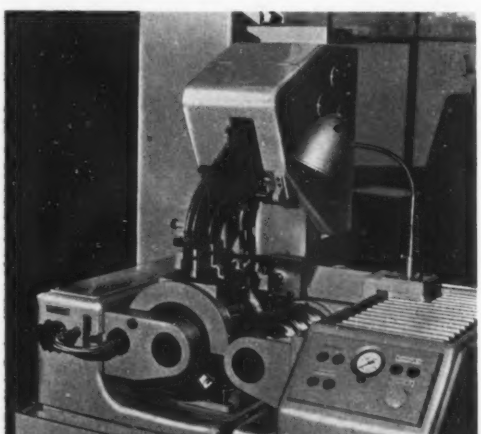


Fig. 1. Fully-automatic, Circular-Die, Thread Rolling Machine, Arranged to Thread Two Workpieces at Each Cycle

A feature of interest on the machine illustrated is that a hopper with two magazine feed channels is fitted, together with a double-ended indexing carrier and two sets of thread rolls. With this arrangement for threading two pieces at each cycle, an output of 150 pieces per min. can be obtained when handling 12-mm. (0·472-in.) diameter by 1⅜-in. long steel hexagon bolts, with a thread length of 1 in. To provide for continuous running, with a minimum of attention by the operator, the supply to the overhead hopper on the machine is maintained by a vertical slot-type elevator, which picks up blanks from a large-capacity floor-mounted container.

Workpieces from 6 to 16 mm. (0·236 to 0·63 in.) diameter, with pitches from 0·5 to 2 mm. (0·020 to 0·080 in.), and up to 4 in. long under the head, can be handled on the machine, and a maximum thread length of 60 mm. (2·36 in.) can be rolled. The products of this factory also include the type GWR80 thread rolling machine, which is hydraulically operated and will handle workpieces from 3 to 80 mm. (⅛ to 3⅛ in.) diameter.

INTERNAL AND FACE GRINDER WITH MULTI-SPINDLE INDEXING WORK TURRET

A combined face and bore grinding machine, which is of interest because it incorporates a 4-spindle, horizontal, indexing work turret, has been introduced by VEB Schleifmaschinenwerk, Berlin. It is intended for handling, on a quantity production basis, types of components required, for example, in the motor car and ball and roller bearing industries. This machine, which is illustrated in Fig. 2, will grind bores from 1 to 3 in. diameter, up to 2 in. long, and the maximum diameter of workpiece that can be accommodated is 7 in.

The 4-station work turret mounted on the left-hand end of the bed indexes in a clockwise direction, and the workpieces are held in hydraulically-operated collets. Parts are loaded and unloaded at the upper front station, and at the next station, face grinding is carried out with the spindle head *A* which is mounted on a raised extension at the rear

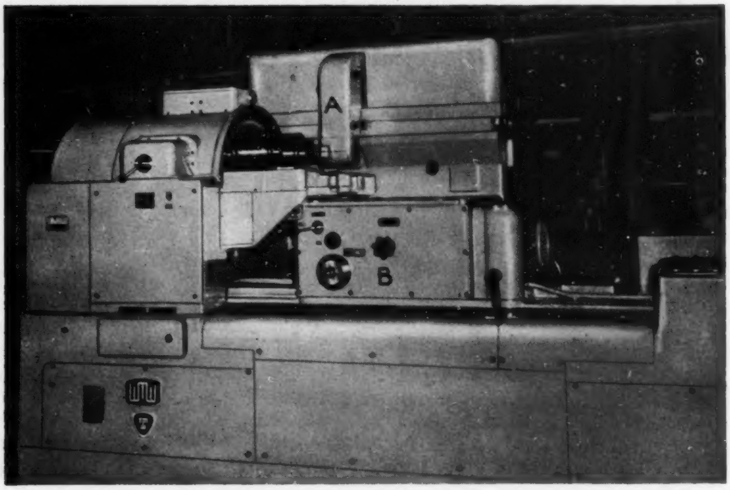


Fig. 2. The Type S1XTP75 x 50 Combined Internal and Face Grinder, which Incorporates a 4-station Indexing Work Turret

of the bed. Rough- and finish-grinding of the bore, at the third and fourth stations, is performed with spindles in the head *B*, which is reciprocated hydraulically along the bed-ways. These spindles are mounted in eccentric sleeves, and the increments of feed are applied by an arrangement of cams.

The machine stops automatically at the end of the grinding cycle, and a guard, not shown in the illustration, is retracted to allow the work to be unloaded. Safety interlocks ensure that the machine cannot be started unless the workpiece is properly clamped and the guard is in position. After each piece has been ground, wheel dressing is carried out, and compensating increments of in-feed are applied automatically. The speed of the work spindles is selected to suit the particular application, and may range from 100 to 240 r.p.m. Steplessly-variable traverse rates from 40 to 400 in. per min. are obtainable for the internal grinding head. A coolant system, which incorporates a magnetic filter, is provided.

NILES VERTICAL TURNING AND BORING MILLS

The latest DKE range of Niles vertical turning and boring mills made by VEB Grossdrehmaschinenbau "7 October," Berlin Weissensee, includes machines with turning capacities of 31½, 39⅜, 49, and 63 in. diameter, which are available in normal and high speed types. A type DKE-1250 machine, with a turning capacity of 49 in., is shown in Fig. 3. Drive to the table is taken through a gearbox, and either eight or sixteen speeds are provided, which can be changed under load. For the 49-in. machine, here shown, speeds up to 280 r.p.m. are available when a 50-h.p. driving motor is fitted.

Steplessly - variable feed rates are available for turning, boring, and facing, and a side tool head, which can be clamped to the column by hand, or hydraulically, can be supplied. Automatic clamping can be provided for

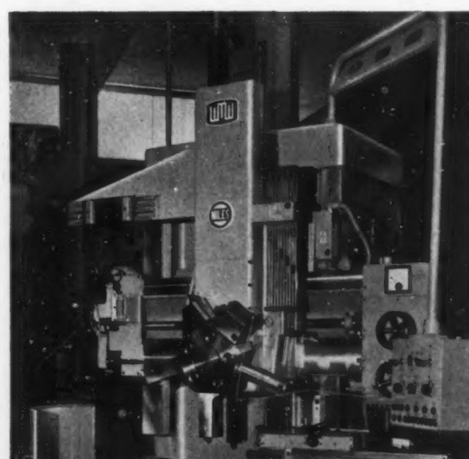


Fig. 3. Niles Type DKE-1250 Vertical Turning and Boring Mill, of 49-in. Turning Capacity, Equipped with a Side Tool Head and an Electric Copying Attachment

locking the cross-slide and the tool ram, if required, also automatic depth stops for the ram movement. The ram can be fitted with either a single tool-post or a 5-station turret, and the latter can be arranged for automatic, electrical indexing.

Other features that can be incorporated include a thread cutting gearbox, an electric copy-turning attachment, and a coolant pump unit and guards. In accordance with modern practice, the various controls for the machine are conveniently centralized on a pendant panel.

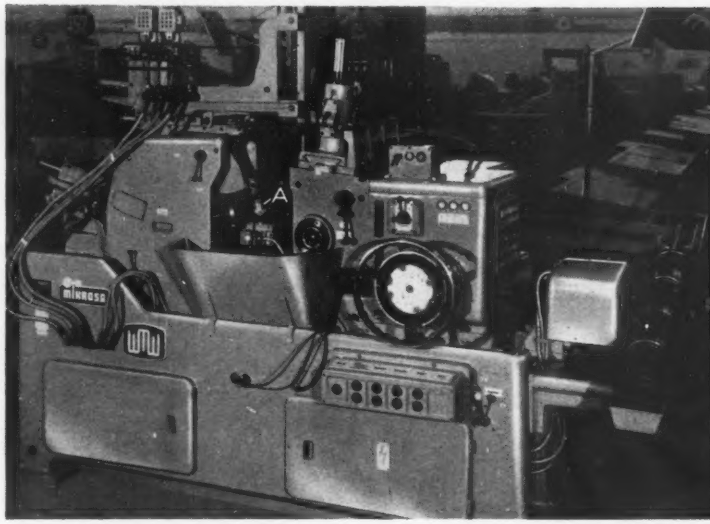


Fig. 4. Mikrosa Centreless Grinder Set-up for Grinding Cylinder Liners on an Automatic Cycle

MIKROSA CENTRELESS GRINDERS

A Mikrosa type SASI 200 centreless grinder, built by VEB Werkzeugmaschinen-und Vorichtungsbau, Leipzig, is shown in Fig. 4, set up for plunge grinding, with an automatic cycle, the peripheral lands on cast iron cylinder liners for diesel engines. There is a land at each end of the liner, and the machine is fitted with two grinding, and two control, wheels.

The liners are loaded into a slightly-inclined magazine mounted on top of the grinding wheel head, and are lowered, in turn, on to a work rest of V-form, by means of a cradle support, which moves vertically in guideways and is actuated by a hydraulic cylinder and piston. Size control is effected by an electric gauging head at A, which pivots down into contact with the periphery of the liner as soon as it is loaded. Upon completion of the grinding cycle, the liner is ejected along the work rest by means of a hydraulic cylinder and piston, and it moves down an inclined runway system to a discharge point. An output of 70 pieces per hour is obtained with this set-up.

Either through-feed or plunge-feed grinding can be carried out on the SASI 200 machine, and it will handle work from $\frac{5}{16}$ to 8 in. diameter. Drive to the 24-in. diameter grinding wheel is taken from a motor of 40 h.p., and the nitrided-steel spindle, which is ground and lapped, is supported in two plain bronze bearings on either side of the V-belt pulley. Ten working speeds, obtained through change gears, are provided for the control wheel, and there is also a high speed for use when diamond truing, with a hydraulically-operated dressing attachment. The control wheel spindle, it may be noted, is mounted in a plain adjustable bearing at each end. In addition to the hydraulic plunge-feed and work ejection features, provision can be made for hydraulically-operated, short-stroke reciprocating movements of the grinding wheel spindle.

Reference may also be made to the type SAASI 125 Mikrosa centreless grinder, of smaller capacity, which is fully-automatic in operation, and was demonstrated plunge grinding a $1\frac{1}{2}$-in. diameter by 2-in. long workpiece. The parts were delivered down a chute from a hopper, and were picked up, in turn, by a loading slide, which then moved transversely to allow the piece to be pushed on to the work rest by a hydraulic piston. At the end of the grinding cycle, the part was ejected towards the front of the machine, and passed beneath the loading slide into a container. For size control purposes, every ninth workpiece was discharged between the anvils of a Zeiss electronic measuring head, which was moved transversely into the gauging position at the appropriate point in the cycle, and any wheel-head adjustment required was then made automatically. After each 100 pieces had been ground, a diamond wheel-dressing device was brought into operation automatically.

HIGH-FREQUENCY INDUCTION HEATING EQUIPMENT

V E B Werkzeugmaschinenfabrik Hermann Schlimme, Berlin-Treptow, are engaged in the development of high-frequency induction and die-electric heating equipment, also units for spark-erosion and ultrasonic machining. Induction heating equipment, recently introduced, includes the type IHU500 universal machine, which is capable of handling gears and other circular workpieces, also shaft components. It is seen in Fig. 5 set up for hardening a large gear-wheel, one tooth at a time, by the indexing method, the inductor being arranged to traverse the tooth space.

The generator is rated at 20 kW., 50 Kc., and gears up to 3 ft. diameter by 8 in. face width, and from 2½ to 12 D.P., can be hardened by the indexing method. For indexing, an adjustable-throw crankpin, on the slotted disc *A*, engages a tooth space of the gear, the crank disc being rotated intermittently.

Two ranges of steplessly-variable, electronically-controlled, traversing speeds are available for the inductor head, namely 0·08 to 0·63 in. per sec. and 0·2 to 2 in. per sec. Hardening takes place on the upward stroke, and the inductor then returns and the workpiece is indexed. The rapid return stroke is at the rate of 1 9/16 or 4¾ in. per sec.

For hardening shafts and other workpieces from 5/16 to 2½ in. diameter, mounted vertically, brackets carrying centres are provided on the face of the machine column, the spindle in the upper bracket *B* being driven at a speed of 200 r.p.m. by means of a small geared motor. Provision is made for swinging the inductor head to the right, into line with the axis of the work centres. The maximum distance between centres is 26 in. and workpieces can be hardened over lengths up to 16½ in. Water for quenching is delivered through a solenoid-operated valve at pressures from 40 to 80 lb. per sq. in., and the rate of flow is 4½ gal. per min.

A machine has also been developed for hardening shafts, including camshafts, up to 63 in. long, and a prototype machine, of 100-kW. rating, for hardening the slideways on machine tool beds up to 12 ft. long, is now in operation in an East German machine tool factory. This machine incorporates a wheeled carriage, which is moved by a chain along guide rails to traverse the work past a stationary inductor head, the latter being adjustable for setting purposes in the vertical and transverse directions.

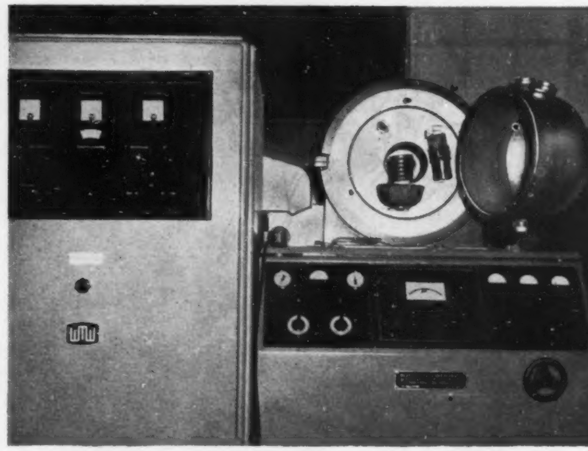


Fig. 6. Vacuum Induction Melting Furnace for Laboratory Use

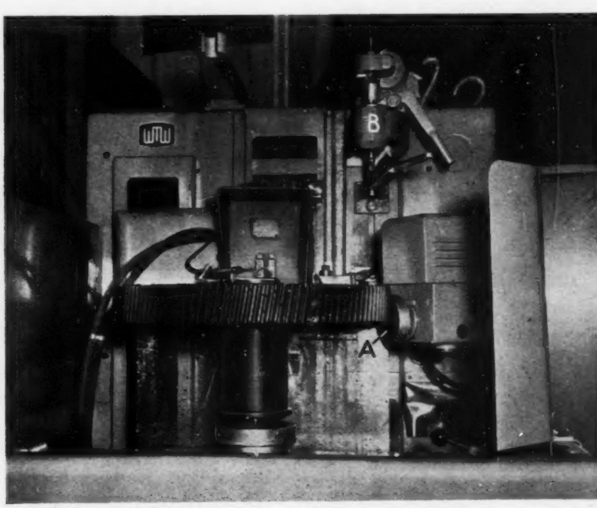


Fig. 5. Type IHU500 Induction Hardening Machine for Gears and Shafts. The Large Gear-wheel Seen in Position is Hardened by the Indexing Method

Another product of the organization is the vacuum induction melting furnace seen in Fig. 6, which has been designed for laboratory use and is fitted with a crucible of 800-gm. (28-oz.) capacity. Power is supplied by a 4-kW. generator, which is one of a new range covering ratings from 2 to 50 kW., and the pump fitted enables a vacuum of 10^{-8} mm. Hg to be drawn.

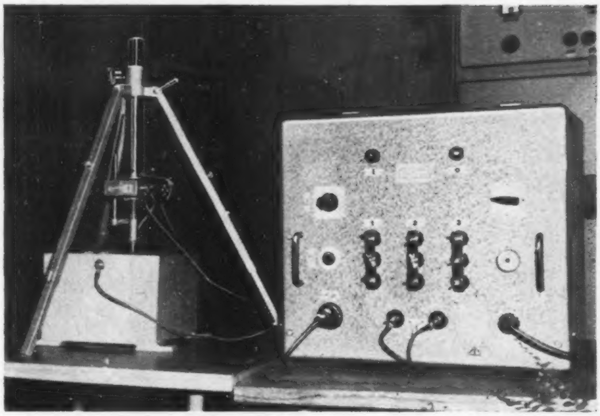


Fig. 8. A Transportable Spark Erosion Unit of 1-kVA. Rating which can be Used on Both Large and Small Workpieces. The Stroke of the Electrode Spindle is 4 in.

SPARK EROSION MACHINES

Shown in Fig. 7 is one of the range of spark erosion machines made by VEB Werkzeugmaschinenfabrik Hermann Schlimme. Designated the type ERFM15, it has an input rating of 12 kVA., and is fitted with a work table measuring 31½ by 19½ in. Screw adjustment is provided for the electrode head, longitudinally and transversely, so that the whole area of the work-table is covered, and fine settings can be made to 0·0004 in. A working stroke of 6 in. is provided for the electrode head by a patented electro-hydraulic feed system. In addition, the compound slide assembly can be adjusted through a distance of 6 in., vertically, by handwheel and screw. Provision can be made for rotating the electrode for producing threads, and an attachment can be fitted for spark machining curved holes.

In addition to the machine illustrated, there is a smaller size, with an input rating of 3 kVA., which incorporates similar design features.

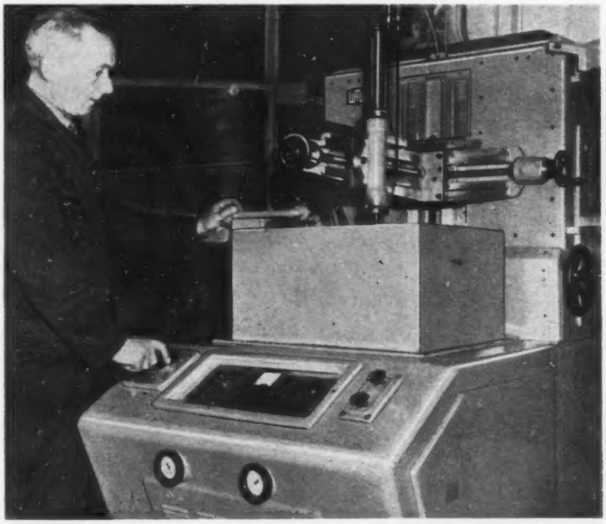


Fig. 7. Spark Erosion Machine of 12-kVA. Rating Built in East Germany. Accurate Adjustment is Provided for the Electrode Head in Both Directions

A portable spark erosion unit, with associated generator of 1 kVA. input rating, is shown in Fig. 8. When mounted on an adjustable tripod carrier, this unit can be conveniently used on the shop floor for removing broken taps or performing other operations on both large and small workpieces. Alternatively, the electrode head can be mounted in the spindle of a vertical drilling machine, for example.

The electrode feed can be varied to suit the application, and it is stated that metal removal rates up to 60 cu. mm. per min. can be obtained. The stroke of the electrode spindle is 4 in.

Reference may also be made to a small ultrasonic machining unit, illustrated in Fig. 9, which has been introduced. It operates at a frequency of 24,000 c.p.s., and incorporates a Zeiss compound worktable which is equipped with a micrometer adjustment.

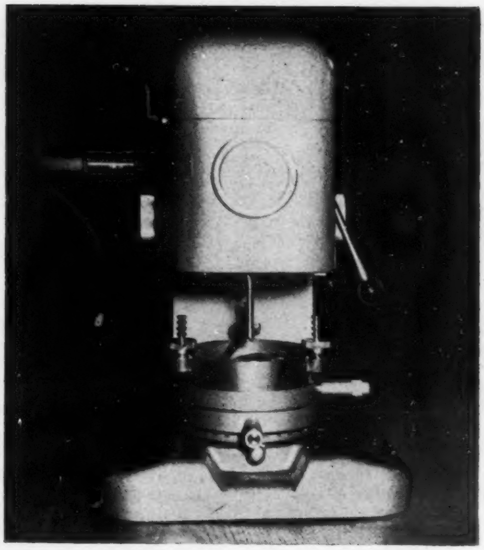


Fig. 9. Small-capacity Ultrasonic Machining Unit Developed in East Germany

ROTARY TRANSFER GRINDING MACHINE

Fig. 10 shows a special-purpose machine of the rotary transfer type which has been built by Wotan-und Zimmerman-Werke A.G. for carrying out grinding operations on the inner face of a cast-iron cup-shaped component for a planetary gear. There are six work-heads mounted on the rotary table, which is indexed hydraulically, and the drive to the work-head spindles is taken from 2-speed pole-changing motors.

A high degree of surface finish is required on the component, and for this reason the operation is carried out in three stages, namely, rough grinding, finish grinding, and polishing. In addition, a close tolerance is specified on the dimension from the ground surface to the face by which the component is located in the chuck. Rough grinding is carried out at the first working station, with a hydraulically-fed head, which is seen immediately to the left of the loading and unloading position. At the next station, the work is automatically gauged, and, by means of a feed-back system, any in-feed adjustment necessary is applied to the rough grinding head. A spindle head of the same unit design performs the finish-grinding operation at the second working station, and the piece is then checked by means of a gauging head at the next index position. Finally, the ground surface is polished by the spindle head seen on the right. With this machine, it is stated, a depth tolerance of 0·0006 in., and a very high surface finish, can be maintained. With these unit heads, which have been developed for grinding and gauging, machines can be built for finishing parts with several faces.

ROCKET TESTING TRACK. It is reported in *Mechanical Engineering* that a track of exceptional accuracy has been provided at the U.S. Air Force Missile Development Centre in New Mexico. Each 2-mile section of track was welded into a continuous length, stretched by as much as 5 ft. and then anchored. Interrupter blades used for speed measurement are installed at 13 ft. intervals, and the accumulated error must not exceed 1 in. over a 7-mile length. The minimum radius specified for "topographical" curves in the track is 2,000,000 ft.

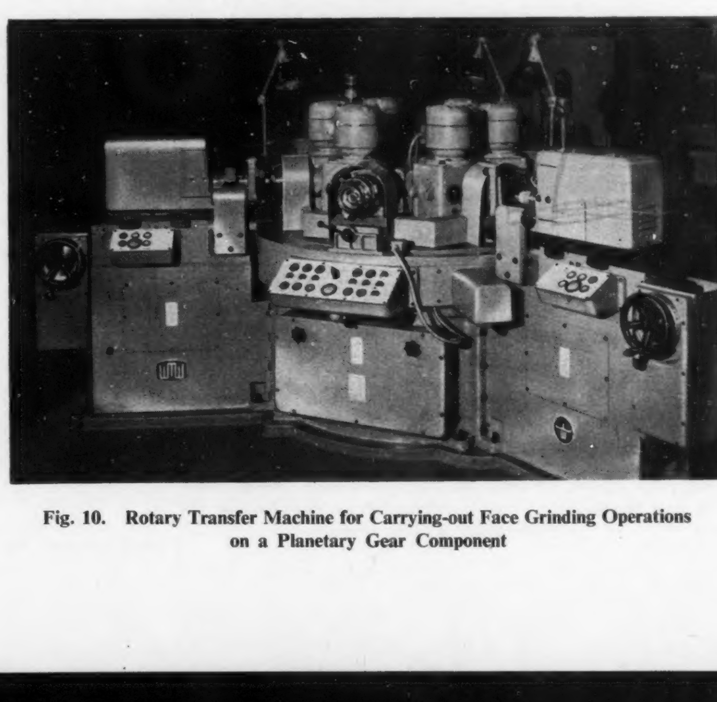


Fig. 10. Rotary Transfer Machine for Carrying-out Face Grinding Operations on a Planetary Gear Component

Conference on Compressed Air as an Aid to Improving Productivity

Mention has already been made in MACHINERY, 92/925—18/4/58, of the conference organized by the Cornwall Section of the Institution of Production Engineers, which was held on April 9 and 10, and more detailed reference is made here to some of the papers presented. A total of five papers was read, and the first, which was delivered by Mr. J. Hodge, M.A., head of the Consultancy Department, Power Jets (Research and Developments), Ltd., was entitled "Industrial Uses of Rotary Compressors." Mr. Hodge explained that the title of his paper was a misnomer, in that he proposed to discuss the design and relative merits of various types of compressors—rotary, reciprocating and axial flow—rather than the uses to which they were put. In the past, the supply of compressed air at pressures up to 50 lb. per sq. in. has been achieved mainly by the use of reciprocating compressors, but in recent years there had been a growing tendency to use rotary compressors of various kinds. All types of compressors, whether rotary or reciprocating, could be sub-divided into two main groups, namely, positive-displacement and aerodynamic. With positive displacement compressors, the volume of air delivered was dependent almost entirely on, and was directly proportional to, the speed of the machine, and optimum efficiency was obtainable only in the region of the pressure ratio for which the compressor was designed. With any substantial departure from this zone, moreover, there was a serious loss of efficiency.

The most important advantage of the positive displacement type of compressor was its freedom from "surging," which was a form of instability frequently encountered with the aerodynamic type.

Rotary positive displacement machines were of four main types, namely, the Roots blower, the BICERA supercharger, the Lysholm compressor, and the vane-type compressor. The Roots blower, in single-stage form, was suitable for pressures of the order of 8 to 10 lb. per sq. in. Certain advantages were offered by the BICERA supercharger, as compared with the Roots-type, in that the greater part of the compression was achieved directly, by means of an internal volumetric change during rotation, and losses due to leakage were reduced.

Rotary-vane type compressors were of well-established design, and could be used, in 2-stage form, for pressures up to 100 lb. per sq. in. The compression was achieved by direct internal volume change, and leakage losses were low because of the number of vanes which formed seals between the high- and low-pressure zones.

Finally, the Lysholm compressor, which was also known as the S.R.M. or Howden compressor, comprised two lobed rotors, meshing together, but geared so that they did not actually touch each other. Various limitations, associated with rotor stiffness and expansion, were imposed, and it appeared, at present, that with the single-stage design, a pressure ratio of 5 : 1, and a throughput of 10,000 cu. ft. per min., were the maxima for this type. With 2-stage units, however, pressures up to 100 lb. per sq. in. could be obtained.

One of the advantages of the Lysholm compressor was that, owing to the absence of rubbing parts, there was no need for any form of internal lubrication, and the air delivered was clean and free from oil.

Aerodynamic compressors, Mr. Hodge continued, were of two basic types, centrifugal and axial flow. A similarity existed between these types, in that the work input to the rotor caused a change in the whirl velocity of the air, which was then converted into pressure. The main difference was that centrifugal force was employed in one type to assist the energy conversion process, but not in the other.

With single-stage centrifugal compressors, the maximum pressure ratio obtainable was usually considered to be in the region of 4 : 1, with a rotor tip speed of about 1,500 ft. per sec. Recent unconfirmed reports of developments in the U.S.A., however, had mentioned pressure ratios of 7 or 8 : 1, with rotor tip speeds of the order of 1,900 ft. per sec.

Advantages of axial flow machines were considerable. Pressure ratios up to about 8 : 1 were possible with a single shaft, even without intercooling, and the multi-staging of normal centrifugal-type compressors to achieve the same result would be very cumbersome. On the other hand, the use of an axial flow machine could rarely be justified for an industrial application, as it was most efficient where large flow rates, of the order of 10,000 cu. ft. per min., and upwards, were required.

In the discussion which followed this paper, Mr. J. O. H. Mulhaus (Climax Rock Drill & Engineering Works, Ltd.) asked the speaker to comment on the relative merits of ball and plain-type bearings for compressors. In reply, Mr. Hodge said that the primary consideration was the anticipated life of the bearing, and that for applications involving speeds up to about 50,000 r.p.m. the use of ball bearings was recommended.

Mr. A. Dunn (Climax Rock Drill & Engineering Works, Ltd.) expressed the opinion that further development was required in connection with prime movers for driving compressors, particularly those of the aerodynamic type. With the latter, there was invariably a need for some form of step-up gearbox, as the running speed of the compressor was so much greater than that of the driver. The introduction of this gearbox necessarily increased the amount of maintenance required, and he felt that increased use of axial flow compressors would be delayed until gas turbine drives were practical.

AIR GAUGING

In opening his paper on air-gauging, Mr. C. J. Tanner [Solex (Gauges), Ltd.] reviewed, briefly, the basic principles of the subject, and pointed out that the greatest advantage of the method was that it enabled a measurement to be magnified without the use of any kind of mechanism, and thus eliminated errors caused by such factors as hysteresis, backlash, wear, and vibration. It was at first thought that the ability to take non-contact measurements was the principal merit of air-gauging, but, although this facility was still of importance in connection with easily-deformable and delicate workpieces, the method was now generally used only where it was impractical to employ contact measurement, and never in preference to the latter.

The methods of taking measurements with air-gauges could be classified broadly under three headings, namely, restriction, direct, and indirect (contact). The indirect, or contact, system was used for the majority of air-gauging applications, and a typical contact measuring head incorporated a poppet-type valve, the stem of which was in contact with the surface of the workpiece. The size of the work at the point of measurement ensured a certain degree of opening of the valve, and consequently affected the flow of air. Such heads could be linked together to form multi-gauging set-ups, or to provide an indication of such conditions as out-of-roundness and straightness. The author then went on to discuss the design and details of some of the various control/indicating instruments, now generally referred to as "air-controllers."

Turning to present day applications of air-gauging, Mr. Tanner said that modern machines frequently incorporated hydraulic or pneumatic means for presenting the gauge to the part, and *vice versa*, and complete gauging installations had been built into conveyors and machine tools. As an example, Fig. 1 shows an in-line transfer machine for performing a number of operations on a motor car crankcase. Components can be seen mounted on the transfer mechanism at the loading station in the foreground, and the multi-column gauging station, which is built into the machine, is in the background. A close-up view of the gauging station is shown in Fig. 2, where a component is in position and the measuring heads are seen extended to enter the bores. This equipment checks the main and cam-shaft

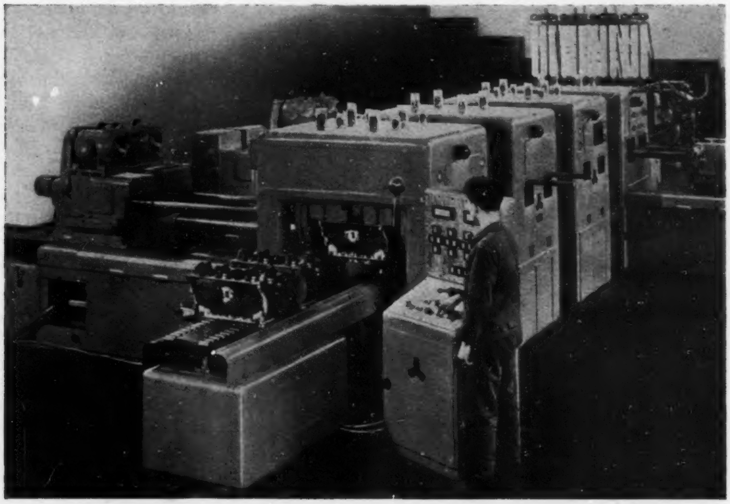


Fig. 1. In-line Transfer Machine with Built-in Air-gauging Equipment for Checking the Main and Camshaft Bores of a Motor Car Crankcase

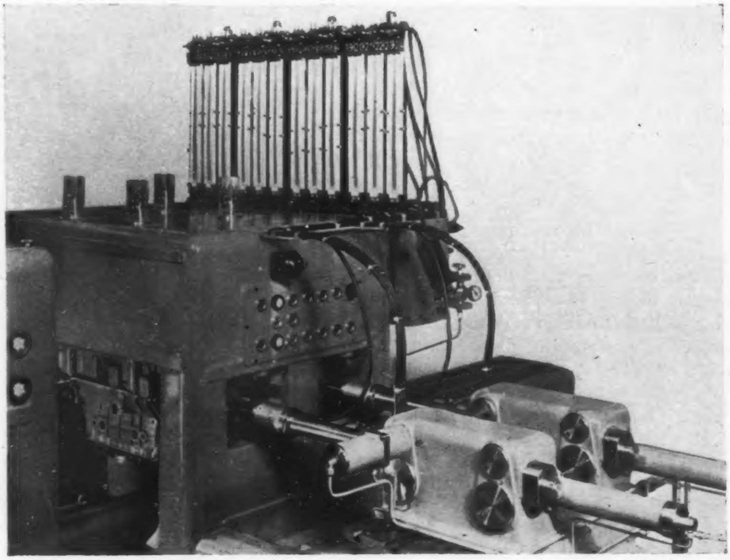


Fig. 2. Close-up View of the Gauging Installation on the Machine Shown in Fig. 1

bores, and provision is made for stopping the machine automatically if the machining limits are exceeded.

As a result of the rapid developments in air-gauging, the speaker continued, a number of terms had been introduced, and for a full understanding of the subject it was desirable that these should be properly defined. The following were among the expressions in most common use, and their definitions.

Production Gauge: Used by the machine operator or setter for measuring the part during or after the machining operation.

Setting Check Gauges: Used by the operator to translate the findings of the production gauge into the necessary slide adjustment of the machine.

Line Inspection Gauge: A combination of a production and setting gauge which determines rapidly one, or a number of, critical dimensions, thereby indicating the drift of tool wear and allowing the necessary corrective action to be taken.

Automatic Machine Control: Linking the production gauge with the machine movements so that the latter are stopped when the limits for the particular workpiece are exceeded.

Automatic sizing: Another method of machine control whereby the gauge automatically slows down, and stops, the in-feed of the tool slide when a given dimension is reached.

In conclusion, Mr. Tanner said that in the immediate future there must be much closer cooperation between the machine tool designer and the gauge designer if we, in this country, were not to fall behind others as regards rates and methods of high-quantity production.

APPLICATIONS OF COMPRESSED AIR

Some interesting examples of the use of compressed air were included in the paper entitled "A User's Experience," which was presented by Mr. W. G. Wood (Rolls-Royce, Ltd.). The press seen in Fig. 3 is employed for both extruding and, subsequently, heading a component. After the extruding stage, the workpiece is pushed up through the die by means of an air-operated plunger which bears against the lower end. The speed at which the part is ejected can be regulated by varying the pressure of the air in the cylinder, by means of a pedal.

With this arrangement, the operator has complete control over ejection and has ample time to grip the workpiece with tongs and transfer it to the heading die which is housed in the same bolster. The part is ejected from the heading die by a blast of compressed air, which blows it clear through a distance of about 6 in.

After certain machining operations, the parts are transferred to a Brayshaw through-feed furnace, where they are heated prior to a stamping process. The entry side of this furnace is equipped with two horizontal conveyors, one on either side of the furnace door, which are arranged at right angles to the direction of flow through the furnace. Each conveyor is operated by an air cylinder, and incorporates a number of transverse troughs for holding the components. The conveyors are indexed alternately, to drop one workpiece at a time into one of a pair of troughs positioned in front of the furnace door, and a further pair of air cylinders is employed to push the parts endwise into the heating chamber. These cylinders are interlocked with those for operating the conveyors,

so that the left-hand conveyor and the right-hand loading ram operate in unison, or *vice versa*, depending on which loading trough was last filled.

When the furnace is charged to capacity, the entry of a new component causes a heated part to be discharged, and the movements of the conveyors and loading rams are under the control of the stamping press operator, who is stationed at the exit end of the furnace.

A considerable increase in productivity, it was stated, had been achieved by operating the furnace in this manner, as hitherto these parts had been heated in an open-face furnace, which had to be charged to capacity. While the parts were being heated, the stamping press stood idle, and, when they were brought to the required temperature, the entire batch had to be stamped before the furnace was re-loaded, as the soaking time for the particular part was critical. As no fresh parts could be loaded into the furnace during the stamping operation, there was again a delay while a fresh charge was heated.

The machine shown in Fig. 4 is used for polishing turbine blades by means of an abrasive belt, which is pulled backwards and forwards across a suitably-formed die. The particular set-up shown in the figure is for polishing the concave surface of a blade which is mounted in the fixture beneath the belt. Above the fixture can be seen the die, with the belt in place, and this die has a number of transverse slots along its entire length. Each of these slots is connected to a longitudinal hole in the body of the die, and this hole is connected to the compressed air supply. When the die and belt are lowered, so that the latter comes into contact with the blade, the compressed air ensures that the belt is kept in overall intimate contact with the workpiece. Moreover, as the air escapes, it provides a cushion between the face of the die and the back of the band, so that wear on both these items is reduced.

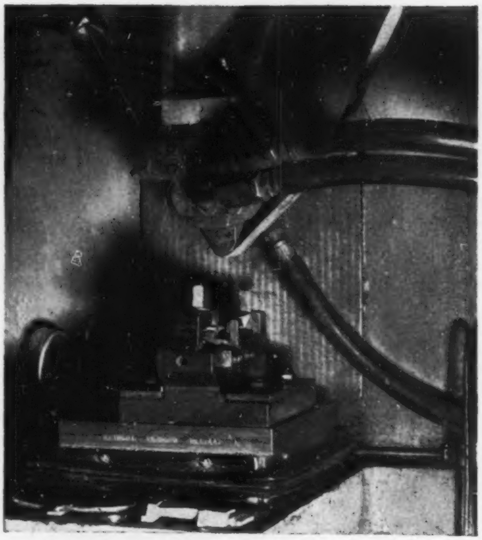


Fig. 4. On this Abrasive-band Machine for Polishing Turbine Blades, Compressed Air Serves to Keep the Band in Overall Intimate Contact with the Blade. Air is Supplied to the Die around which the Band is Flexed, and Escapes through Slots Machined in the Curved Surface

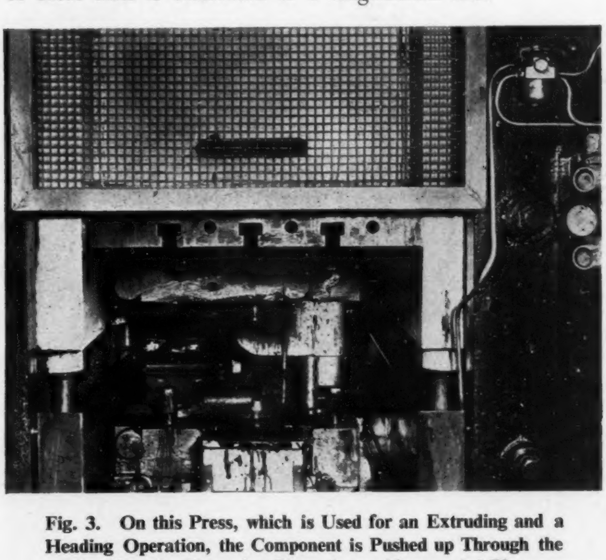


Fig. 3. On this Press, which is Used for an Extruding and a Heading Operation, the Component is Pushed up Through the Die, after the Extrusion Stage, by an Air-operated Plunger

AIR-OPERATED EQUIPMENT

The final paper of the Conference, which was delivered by Mr. N. P. Watts, M.S.M.A. (Benton & Stone, Ltd.), was entitled "Air-operated Equipment." In his opening remarks, Mr. Watts commented on the fact that recent developments in the field of cutting tools had enabled spindle speeds and feed rates to be increased, with the result that hand-

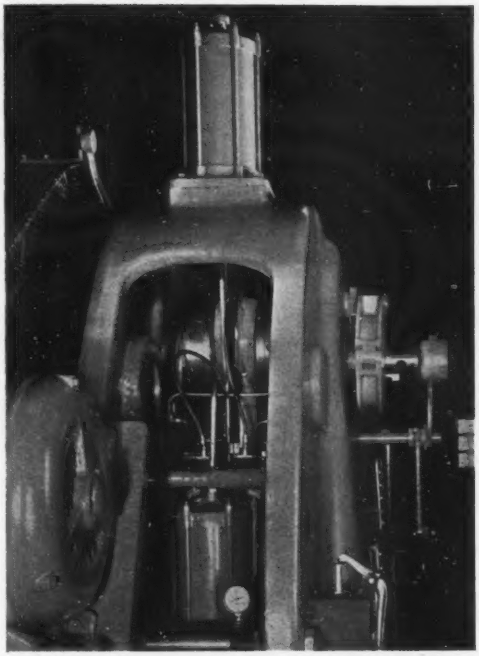


Fig. 5. H.M.E. Crank Press with a 6-in. Air Cylinder for Counterbalancing the Slide. The Expansion Chamber seen Between the Frames Ensures a Constant Pressure of Air

ling time was tending to occupy a greater percentage of the production cycle. Appreciable savings could be effected in this respect by the use of pneumatically - operated loading, clamping, and ejecting mechanisms. Such mechanisms also ensured a more consistent production rate and reduced operator fatigue.

In connection with the latter point, Mr. Watts referred to a particular Taylor & Challen 200-ton press on which all the controls were air-operated. One advantage which had been obtained by controlling the press movements in this manner was that the operation of the main clutch was effected positively, and at a predetermined speed. Normally, all the force required to depress the clutch pedal was supplied by the operator, and, when he became tired, there was a tendency to engage the clutch in a hesitant manner, which resulted in severe wear of the main driving key.

An H.M.E. crank press, a close-up view of which is given in Fig. 5, incorporates a 6-in. diameter air cylinder to counterbalance the weight of the slide and relieve the bearing load, so that the life is increased. Pressure of the air is adjusted to suit the weight to be carried, and the expansion chamber seen between the frames is provided to maintain a constant pressure. It may be noted that the guard on this machine is foot-operated, and that the final closing movement serves to actuate a control valve for the air supply to the clutch cylinder.

An example of air-operated equipment for automatic assembly is illustrated in Fig. 6. This machine, which was developed by a well-known radio manufacturing company, provides for assembling and clinching tags to the panel at the left in Fig. 7, at the rate of 30 per min. A completed panel, with the tags assembled and clinched, is seen at the right in this figure. It may be noted that with the previous method of assembly, which was entirely manual, the maximum output obtained was only two complete assemblies per min.

As can be seen from Fig. 6, the machine incorporates a 24-station, air-operated rotary table, and

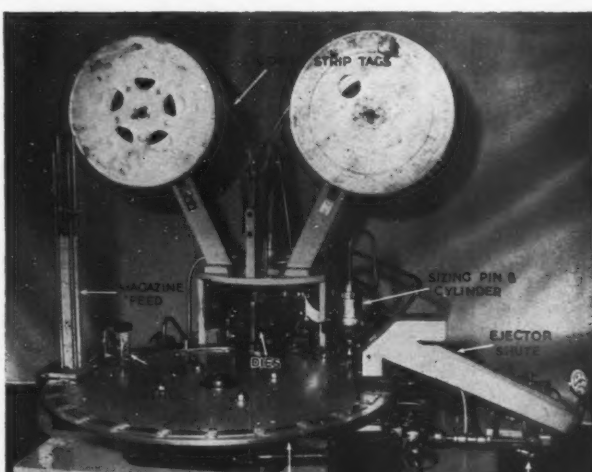


Fig. 6. A 24-station, Pneumatically-operated, Fully-automatic Machine for Assembling and Clinching Radio Panel Tags

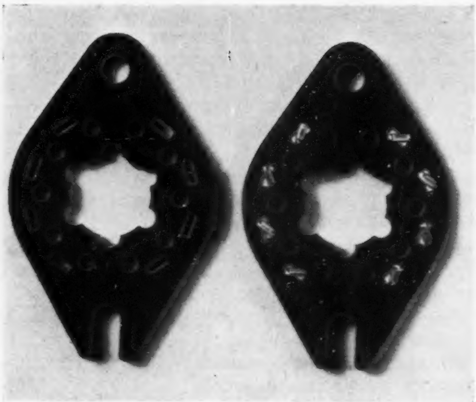


Fig. 7. (Left) A Blank Panel. (Right) A Panel with the Tags Assembled and Clinched. The Tags are Delivered to the Machine in Strip Form

the blank panels are fed to this table from the magazine at the extreme left. Adjacent to this unit there is mounted a "no-panel" control, in the form of a micro-switch, which gives a signal when the supply of blanks in the magazine has been exhausted, and automatically stops the operation of the machine.

Tags, for the right- and left-hand groups of holes in the blank panel, are fed in continuous strip form from the two reels seen above the machine. After insertion in the panel, each tag is twisted, to clinch it in position, and the assembled section of strip is sheared, to separate it from the remainder of the coil. To ensure the specified clearance between the tags, when they have been twisted, the machine incorporates a siding plunger, which is operated by the air cylinder seen just to the left of the ejector chute, in Fig. 6.

In Fig. 8 is shown a rear view of this machine, in which most of the pneumatic equipment is visible. Here, may be seen the air cylinder for operating the shearing tool, also two silencers in the bottom left-hand corner. The top plate of the rotary table, the die assembly, and the magazine can be changed, to enable this machine to handle panels with either 8 or 12 tags. The control system, which is entirely electro-pneumatic, is sequentially arranged so that the completion of one movement initiates the next, and is fully-interlocked to ensure that the rotary table cannot index until the tools are clear, and that the tools cannot operate unless the rotary table has completed its indexing movement.

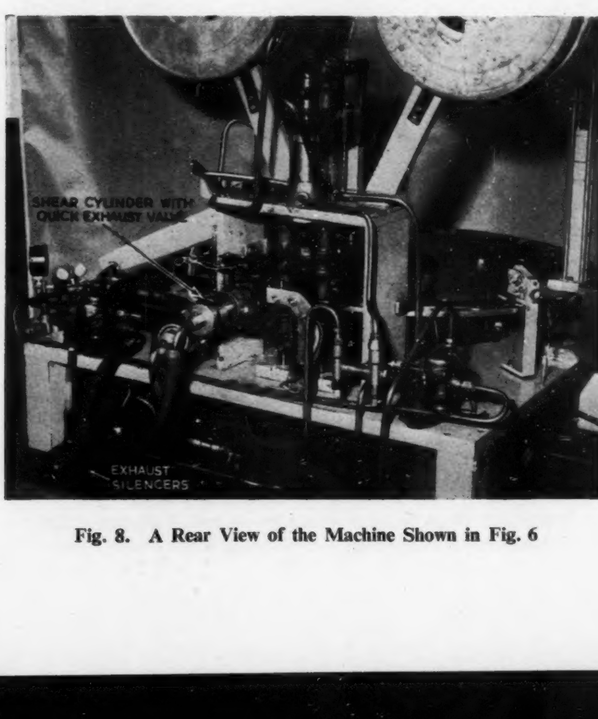


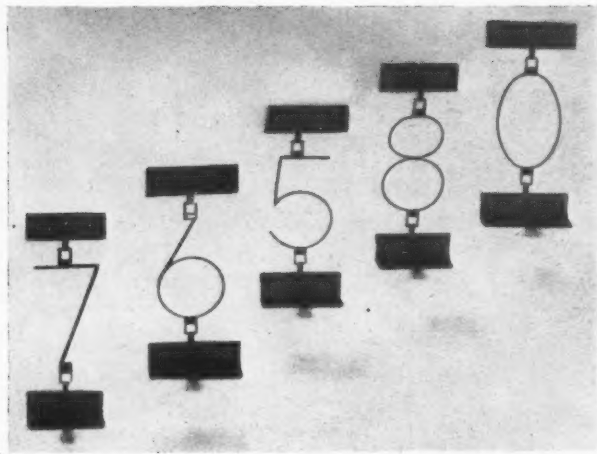
Fig. 8. A Rear View of the Machine Shown in Fig. 6

A LARGE SOLAR FURNACE INSTALLATION is being erected at the U.S. Quartermaster Research and Engineering Centre, Natick, Mass., U.S.A., to provide temperatures comparable to those generated near atomic explosions. This furnace will be employed for preliminary tests on materials intended for protection against the thermal effects of such explosions.

The installation, which will have an energy equivalent of about 28 kW., will comprise four principal units. At one end there will be a flat heliostat mirror measuring 40 by 36 ft., which will be automatically positioned so that the sun's rays will be constantly reflected on to a concentrating mirror, which is located at the opposite end of the installation, 96 ft. away.

The concentrating array will comprise 180 curved surface mirrors, each of 23·5 in. diameter, which will focus the beam in the test chamber, located between the two mirrors. An alternator, in the form of a venetian blind type shutter will be provided between the concentrator and the chamber, to enable temperature to be controlled. The heated area within the chamber will have a diameter of 4 in.

Blanking "Number" Anodes from Thin Strip



Some unusual production problems are encountered in connection with components for electronic computers. An example is afforded by a set of delicate "number" anodes, 0·005 in. thick, for an all-electronic numerical indicator tube. The width of the metal varies with the number, but may be as little as 0·007 in. By means of tools of special design, and high quality tool-making, the Be Cu Manufacturing Co., Newark, N.J., U.S.A., are making these unusually narrow parts as stampings. A group of the number anodes is seen in the heading illustration.

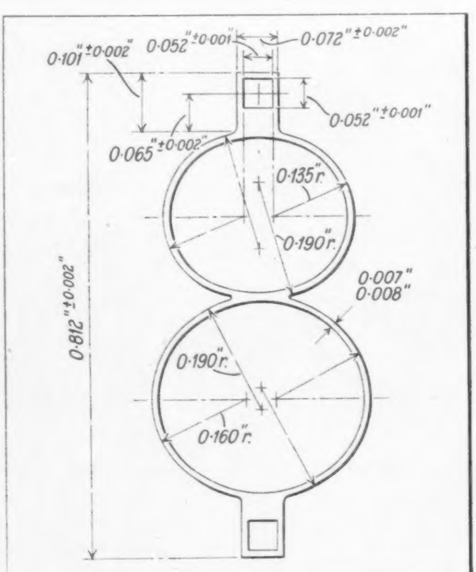


Fig. 1. Details of the Stamping for the Number 8 Anode Used in an All-electric Numerical Indicator Tube

Ten anodes, for the numbers from 0 to 9, are mounted in the glass envelope of the numerical indicator tube. When a tube of this type is connected in a suitable electronic circuit, any individual number can be made luminous by applying the proper voltage to the anode. This tube was specially developed for use in electronic instruments such as digital computers and counters.

Proportions of the anodes must be held within close limits to ensure clear reading of the one luminous numeral, despite the fact that all the anodes are arranged in a pack facing the viewing end of the tube. The form and limits for the number 8 anode are indicated in Fig. 1.

Design considerations demand that the numbers should have approximately equal surface areas. Since each number has a different developed length, the face width of the metal forming a digit is adjusted to obtain the desired area. Widths range from 0·032 to 0·034 in. for the number 1 to 0·007 to 0·008 in. for the number 8. Seven of the numbers have the same cross-sectional width, namely, 0·011 to 0·012 in. Although experimental numbers were subsequently made from several different metals, the dies were originally designed to stamp the anodes from 0·005-in. thick strips of an alloy containing 80 per cent nickel and 20 per cent chromium.

Owing to the extremely small clearances required between the punches and dies it was not possible

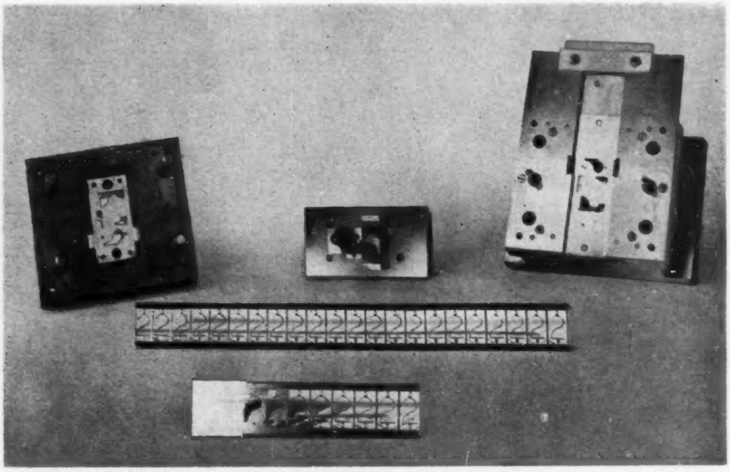


Fig. 2. **Number 2 Anodes (foreground) are Produced with this Tool. The Three Basic Parts are the Punch (centre), Die (right) and Punch Guide (left, lower face up)**

to use standard die sets. Instead, progressive dies, of a type previously employed by the company for producing sub-miniature parts, were designed and constructed. Since the 6 and the 9 are made from the same die, only nine dies were required. Dies for the anodes 2 and 8 are shown in Fig. 2 and 3, respectively.

The tools were designed for operation in a short stroke press and each consists of three parts—the punch, a punch guide, and the die. The punch guide serves three purposes. It guides the punch, holds the workpiece in place during the stamping operation, and then strips the part.

Since the individual punches do not leave the punch guide, its thickness and the length of the punches both depend on the stroke of the press and the length of bearing required for satisfactory punch guidance. For the anode tools, the punch guides are approximately 1 in. thick. To permit of feeding the stock, two pairs of springs seated in the die lift the punch guide when the punch is in the raised position. This vertical movement is restricted by four relieved cap-screws secured to the die, and alignment is maintained by four pins mounted on the punch guide. The downward motion of the punch is transmitted to the punch guide by means of two springs mounted between the two members. The lower and upper surfaces of punch guides are seen at the left in Fig. 2 and 3, respectively.

A small guide plate, with holes of the exact shapes of the individual punches, is part of the punch guide, and is secured to the underside of this member. When the punch descends, this plate is lowered between the stock guides, contacts the top of the work, and holds it securely in place with a force of about 50 lb.

The upper tool incorporates the individual punches, and a punch-holder which fits into a

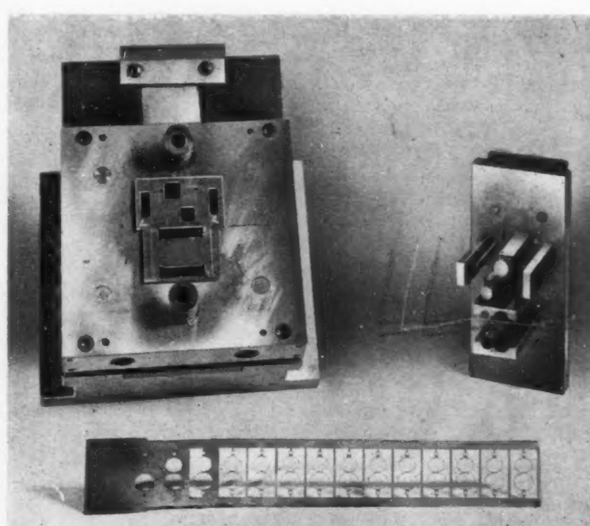


Fig. 3. **Four Stamping Operations are Required to Produce the Number 8 Anode. The Die with the Punch Guide in Position is Seen at the Left. In operation the Punch (right) Never Leaves the Punch Guide**

T-slot in the ram of the press. A slight amount of float is permitted between the punch and the ram, so that the punch guide alone directs the motion of the punches. The latter are machined to the required anode shapes over a distance which is only a little greater than the stroke of the press. For convenience, the remaining length of each punch is made rectangular in section and serves for guidance and support. The punch guide (with the exception of the lower guide plate) is made to suit the rectangular portion of the punches.

Each lower tool consists of four parts: two guides for the strip stock, a die-plate, and the die-holder. The die for the number 2 anode is seen at the right in Fig. 2. Two punches straddle the strip stock and cut away a portion from each side at each stroke of the ram. When the metal is advanced, the forward edges of the untrimmed portion engage stops in the two guides.

In operation, as the press ram descends, the punch-holder compresses the springs in the upper face of the punch guide. The punch guide then moves down, against the action of the springs in the die, to contact and hold the stock firmly. With continued downward movement of the ram, the punches, directed by the punch guide, stamp out the workpiece. On the up-stroke, the punches are stripped from the work before the punch guide is allowed to rise.

Due to the delicate nature of the anodes, the strip stock is advanced manually along the work guides to the stop for the next stamping operation after each stroke of the ram. As many as four stations are employed for stamping a number. Stages required to produce the numbers 2 and 8 are indicated by the strips in the foreground in Fig. 2 and 3. Anodes are left in the strips for transport.

The dies are made entirely from a high-carbon high-chrome steel, with low warping characteristics. Punches, and the die plates, are hardened to 60 to 62 Rockwell C. The clearances between the punches and the dies are not easily measured but are of the order of 0·0002 in.

Anode shapes were first laid out on pieces of aluminium ⅛ in. thick. These shapes were then cut out on a band saw and filed to within about 0·002 in. of the desired forms. Then, using the shapes as templates on a pantograph milling machine adjusted to a 5 to 1 ratio, the punches were produced.

After they had been hardened, the punches were used to lay out the holes in both the die-plate and the bottom plate for the punch guide. The material to be removed is machined and filed away until the punches can be employed as broaches to finish the holes.

Fig. 4. Set-up for Electric Discharge Machining a Square Hole of 0·052-in. Side in a Die Plate. A Brass Electrode is Employed

For convenience in machining the upper rectangular-shaped guide holes, each punch guide is made in a number of pieces. Spark machining also facilitated the production of the tools. In Fig. 4, an Elox electric discharge machine is shown set up for producing a small rectangular hole in one of the die plates.

Diamond Honing Unhardened Steel. Diagrit Diamond Tools, Ltd., Pattenden Lane, Marden, Kent, report that considerable economies are being obtained by diamond honing bores in rocker arms for Rootes diesel engines. These rocker arms are machined from forgings of En 16T steel, and a special bond was developed to enable the bores to be honed with diamond, while in the soft state, without picking-up. It is stated that, as compared with the use of conventional abrasive sticks, the cost of honing the large centre bore has been reduced from 3·5 to 1·7d. The corresponding figures for the outer bores, which are of smaller diameter, are 2·5 and 1·1d. (each). Apart from this economy, there has been a saving in setting time, and rounder and more accurate holes are said to be obtained with the diamond hones.

Holbrook Precision Mould Maker's Lathe

The Holbrook Machine Tool Co., Ltd., Stratford, London, E.15, have introduced the Model M No. 15/20 precision mould maker's lathe, shown in Fig. 1, which has been developed from their Model D No. 15 toolroom lathe, and is noteworthy for its versatility. By the provision of a slow-speed unit for the headstock, a pitch variator, hydraulic copying slides, internal and external thread milling heads, and internal and external grinding attachments with diamond wheel dressers, it has been made possible to complete a mould in one setting.

Workpieces up to 30 in. long are admitted between centres, and the swing capacity over the bed is 21 in., and over the carriage, 14 in. For normal turning operations, 18 spindle speeds, from 15 to 1,000 r.p.m., are provided, the main drive being taken from a 5-h.p motor. For thread milling, a range of 18 slow speeds, from 0·15 to 10 r.p.m., is obtainable through a worm and worm-wheel and a separate motor, of 1 h.p., mounted on top of the headstock. A control lever on the headstock mechanically and electrically interlocks the two drives for safety purposes.

A panel on the front of the headstock houses push-buttons for "forward," "stop," "reverse" and "inching" control of both driving motors, and electric limit switches are provided on each side of the carriage whereby the motors can be automatically stopped by dynamic braking, when cutting threads in either direction of carriage traverse.

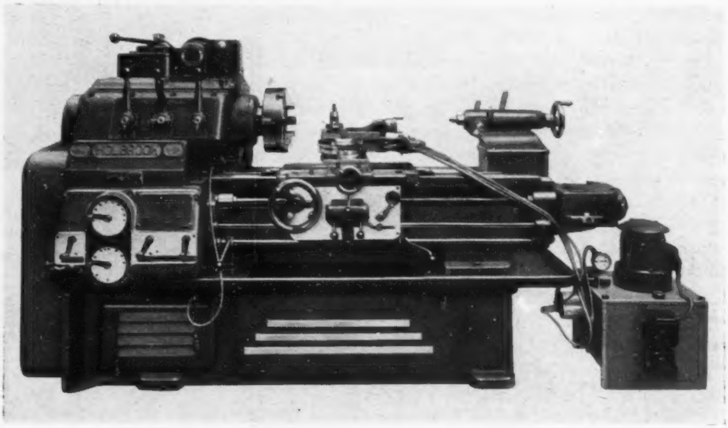


Fig. 1 (above). Holbrook Model M No. 15/20 Mould Maker's Lathe. The Design of this Machine and the Equipment Provided Enable a Mould to be Completed in One Setting

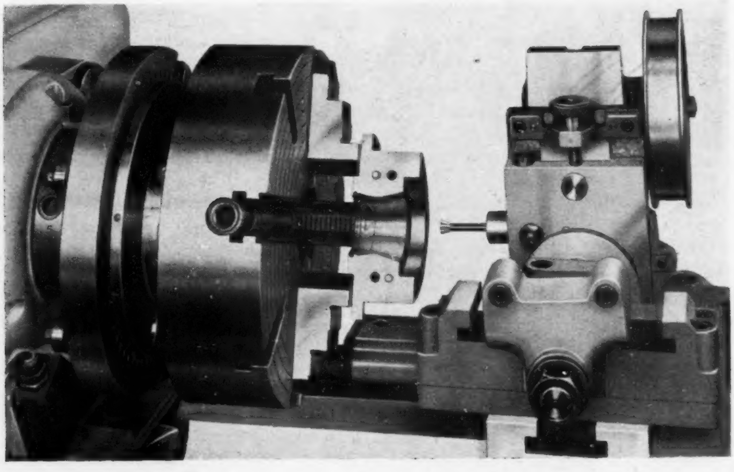


Fig. 2. Set-up on the Holbrook Lathe for an Internal Thread Milling Operation on a Mould, which is Shown in Section, for Clarity

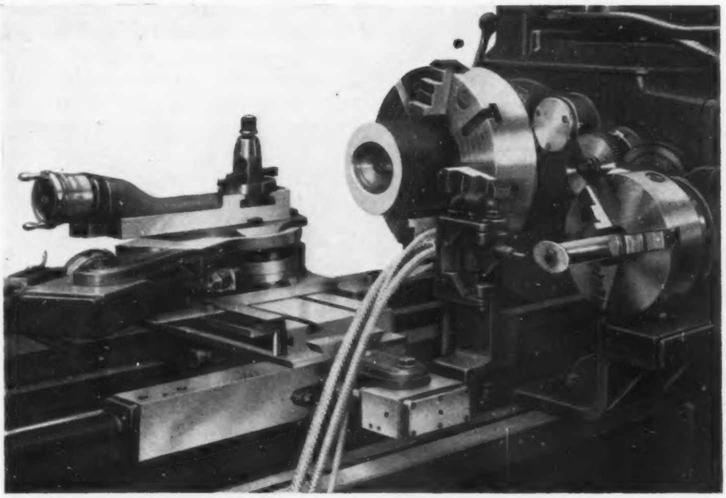


Fig. 3. Rear View of the Lathe Showing the Application of a Rotating Master for Producing a Non-circular Form

The quick-change gearbox provides 60 threads from 1 to 60 t.p.i., and a range of sliding and surfacing feeds, from 0·001 to 0·062 in. per spindle rev.

Fig. 2 shows the lathe set up with the internal thread-milling attachment. The drive to the latter is taken by belt from a motor and bracket unit, not shown, which is applicable to the various other attachments that are available. In this illustration, the workpiece, shown in section for clarity, is mounted in a chuck, which, in turn, is carried on an index plate attached to the spindle nose. Adjustable trips are provided on the plate which operate a limit switch to stop the headstock motor when the workpiece has rotated through the required number of degrees, as required, for example, when a milled thread must start and finish in specified angular positions.

A pitch variator is fitted at the tailstock end of the bed, which enables internal or external threads of increased or decreased pitch to be produced, as is necessary where provision must be made for moulding contraction. The variation is obtained by means of a hardened steel transverse slide, which is coupled to the lead screw by change gears, and produces an axial movement of the lead screw abutment, and therefore of the screw itself, during the carriage traverse. A built-in safety switch prevents over-run of the transverse slide. With this arrangement, an increase or decrease of pitch ranging from 0·033 in. per inch for 12 in. of carriage travel, to 0·013 in. per inch for 30 in. of travel, is obtained.

Provision is made for hydraulic profiling from both the lower cross slide and the swivelling compound slide, and a 1 to 1 ratio gear drive from the headstock spindle to a chuck at the rear enables a rotating master to be employed when a non-circular

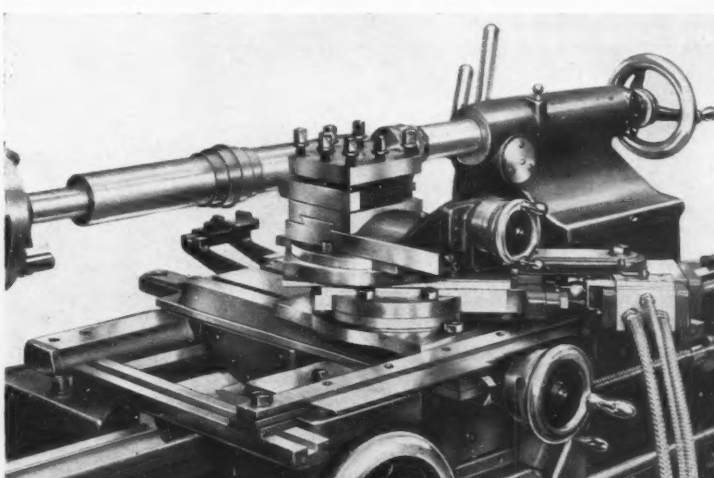


Fig. 4. Set-up for Turning Shafts and Other Shouldered Workpieces

form is to be produced. Fig. 3 is a view from the rear of the lathe showing a rotating master. The shouldered form on the workpiece in the axial direction is produced by the hydraulic copying slide of the compound rest, which is set at an angle of 45 deg. and is controlled by a template mounted along the front of the carriage. The oval, rotating master is engaged by a stylus on the lower cross slide, which is actuated by a hydraulic piston and cylinder at the rear. For normal turning operations, the lower cross slide is anchored to the bed by the tapered stud which, for the application shown, couples the lower cross slide to the hydraulic cylinder.

Profiled workpieces, for example, bottle moulds, can be copy turned by mounting the stylus unit on the main cross slide, the form being controlled, during the carriage traverse, by a flat template attached to brackets at the rear of the bed. A mechanical taper turning attachment, for tapers up to 14 in. long, is also included in the equipment.

With the swivelling hydraulic copying slide set at an angle of 45 deg., as seen in Fig. 4, shafts and other components with square shoulders can be turned, using a template holder which extends in front of the carriage, and is attached to brackets fastened to the bedways. Transverse copying, using the cross-slide traverse motion, can be performed under the control of a template mounted transversely on the carriage. A travel of 3 in. is provided for the swivelling hydraulic copying slide, and the top slide has a hand adjustment of 2⅞ in. The tool-post itself is also adjustable along dovetail ways for setting purposes.

Pressure oil for the hydraulic copying slides is supplied by the self-contained, motor-driven pump unit seen at the right-hand end of the machine. The electric contactor gear for the main drive and other units is housed in a separate cabinet, remote from the lathe.

Bedford Mobile Gauge Inspection Unit

James Bedford & Co. (Halifax), Ltd., Victoria Road, Sowerby Bridge, Yorks, have recently developed the mobile unit, here illustrated, to facilitate the inspection of gauges and tools. Its use avoids the need for withdrawing gauges and jigs from machine and assembly lines for periodic checking. Regular tours of inspection can be organized through a large factory, so that a close check can be kept on all gauges in current use. In this way, man-hours can be saved, and the number of gauges required can frequently be reduced.

There is a large foolscap drawer for filing records and a drawer and cupboard for carrying instruments and spare gauges. If required, a 50-ft. extension flex, with a spring-operated take-up reel, can be provided, to supply power for electric comparators and other types of electrically-operated instruments.

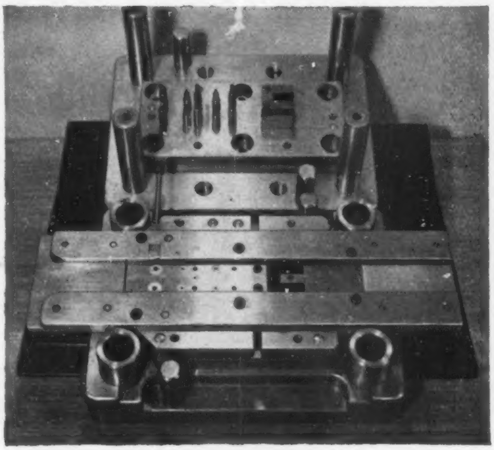
Measuring 42 by 24 in., the top of the unit is covered with green linoleum, and a chromium-plated edging strip is fitted which prevents instruments from sliding off.

A pull-out writing shelf is provided and there is a folding stool for the inspector. The drawers have ball-bearing slides, and both the drawers and cupboard are fitted with locks. The unit, which is made of sheet steel and is 36 in. high, is mounted on ball-bearing, rubber-tyred wheels and can be easily manœuvred.

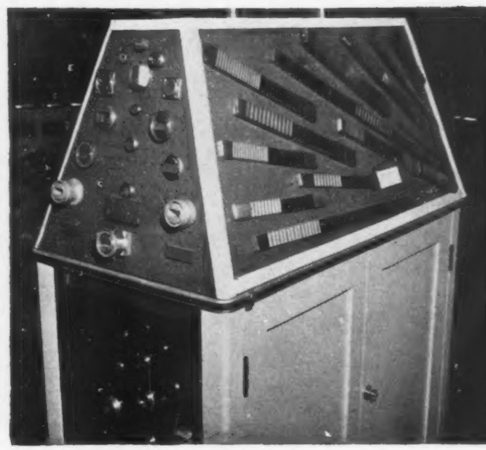
Bedford Mobile Inspection Unit which Enables Gauges and Tools to be Checked on Site

Round Olympia with a Camera

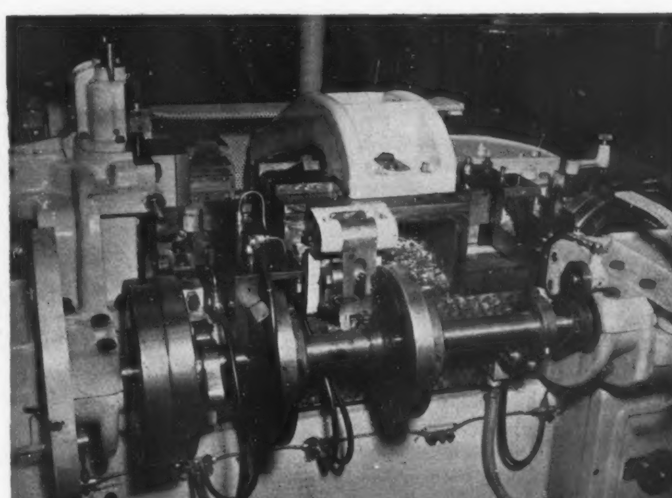
The Gauge and Tool Exhibition



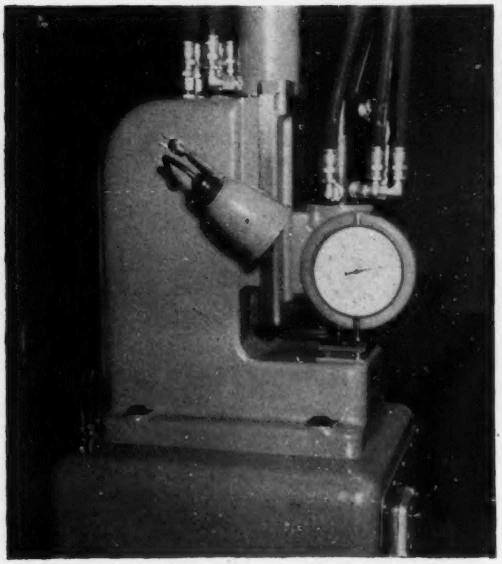
This combination tool, exhibited by Lenchs (Birmingham), Ltd., is fitted with inserts of a new wear-resisting grade of Oakaloy tungsten carbide, to withstand the severe conditions involved in the production of condenser laminations from silicon steel strip. The main shape of the laminations is produced by a punch having a one-piece carbide end surface, in conjunction with a die aperture lined with carbide strips. Solid carbide bush inserts in the die plate, and carbide-tipped punches, provide for the production of rivet holes



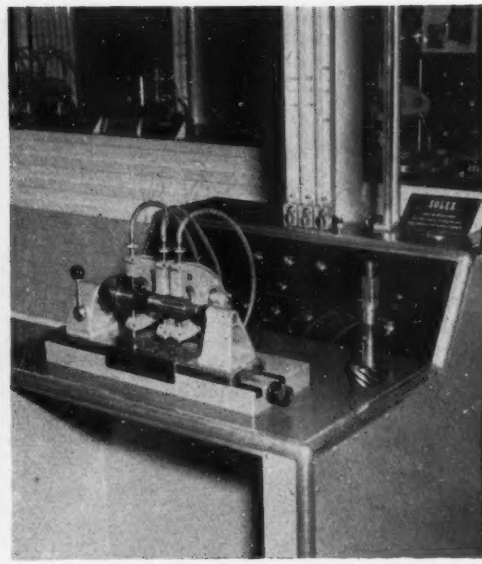
Among the exhibits on the stand of W. H. Marley & Co., Ltd., were these broaches for finishing wave-guide flanges and examples of components produced with them. The cutting teeth on the broaches are arranged to operate on opposite sides of the rectangular openings in succession. Two sides, which have been finished by the first sets of teeth, can thus be employed to guide the broach while the second sets are cutting. In this way it is ensured that the finished surfaces are exactly at 90 deg. to their adjacent sides



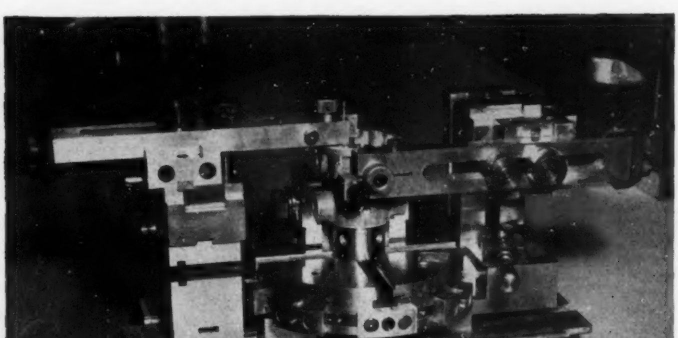
With this set-up on a British-built U.S. multi-slide machine, shown by Rockwell Machine Tool Co., Ltd., electrical switch contacts were being produced from 16-s.w.g. brass strip, 1½ in. wide. After piercing, slotting, cropping and forming operations have been completed in a press tool near the machine centre, the part is gripped by positively-acting fingers, and cropped from the strip. Next, the part is formed to a U-shape round a vertical post, and then pushed down the post to a position at which a long and a short slot are punched in the bottom of the U-shape, before the piece is ejected



This exhibit, by Hayes Engineers (Leeds), Ltd., was staged to demonstrate the accuracy with which the movements of machine slides can be controlled by the Hayes 180-deg. hydraulic tracer control valve. A vertical slide is moved down by a hydraulic cylinder, for which the supply of oil is controlled by a valve mounted on the slide, until the valve stylus touches the horizontal surface. A dial gauge carried on the slide is graduated in 0.0001-in. divisions and the accuracy with which the slide is stopped, normally within 0.001 in., is checked by successive readings of the gauge

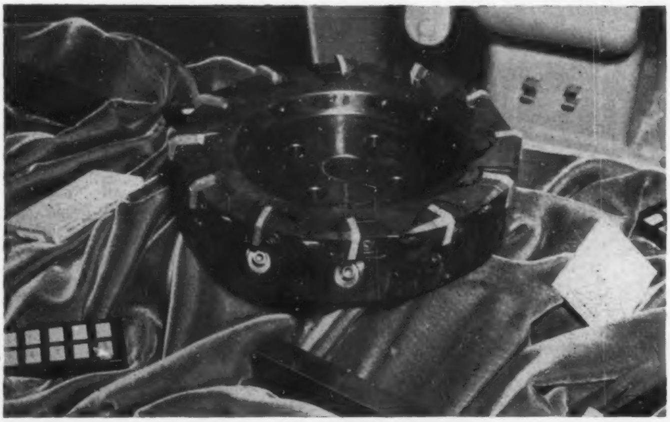


Solex (Gauges), Ltd., showed this unit which is designed for the inspection of three diameters on rear axle pinion shafts. Held between centres, the shafts are engaged by standard Solex caliper gauging units, and the readings are shown on the manometer tubes at the rear. In addition, there are three sets of coloured lights on an inclined surface below the manometers, labelled " all dimensions O.K. " " over size " and " under size," separate lamps being provided for the two latter conditions of each of the three diameters. The manometer tubes are automatically topped-up to compensate for evaporation

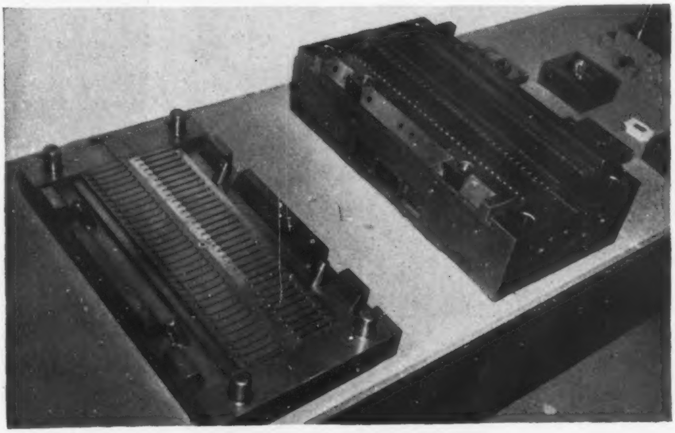


The only parts of this fixture, shown on the stand of Wharton & Wilcocks, Ltd., which are not included in the kit for the basic Wharton system are the graduated indexing table and its associated jig-bored stops. When four $\frac{3}{16}$-in. holes have been drilled in the top face of a light alloy valve body, the fixture is turned through 90 deg., so that it rests on feet on the further side, and four more holes of $\frac{11}{32}$ in. diameter are drilled in the outside bosses. The bush plates are hinged so that they can be swung aside for loading, and the partly-machined casting is positioned by a central bore and by the outside bosses

Hot forging of T-pieces from brass and duralumin billets was demonstrated on this 100-ton press by Taylor & Challen, Ltd. As described in *Machinery*, 91/258-2/8/57, this machine incorporates a mechanism at the right-hand side whereby a punch slide can be reciprocated very rapidly to adminster a stabbing blow. This action occurs immediately after the toggle vice has closed and the top and left-hand side punches have operated. The effect is to backward-extrude a solid portion of the billet, to produce the longer branch of the forging



Among examples of applications of Sintox ceramic cutting tool tips on the stand of the English Steel Tool Corporation, Ltd., was this 12-in. diameter face milling cutter. Equipped with 12 Sintox blades, the cutter is designed for milling operations on graphite blocks employed in nuclear reactor construction. The high abrasion resistance of the ceramic enables a life up to 10 times that of high-speed steel blades to be obtained. The blades are held by a patented clamping arrangement which allows for accurate adjustment, and they can quickly be changed



B.I.P. Tools, Ltd., showed this 64-cavity injection moulding tool for the production of hair curlers from polystyrene. The mould cavities were made from separate pieces of beryllium copper by the hot hobbing process and were subsequently machined to size before being fitted into the tool. Because of the higher heat conductivity of beryllium copper, the mould can be operated on a shorter time cycle than could a similar mould with steel cavities, resulting in an increase of about 20 per cent in productivity

New Equipment at the Fifth Gauge and Tool Exhibition

Attention has already been drawn in earlier issues of MACHINERY to some of the recently introduced items which were shown at the Gauge & Tool Exhibition, and some other new products displayed are here considered.

MATRIX 3-DIMENSIONAL MEASURING MACHINE

Developed from the Matrix No. 59 jig borer, the measuring machine shown in Fig. 1, which was exhibited by the Coventry Gauge & Tool Co., Ltd., Fletchamstead Highway, Coventry, is intended for checking a variety of workpieces in three planes to a high degree of accuracy.

The spindle is rotated by a handwheel only, and the quill in which it is mounted has 4 in. of axial adjustment in bearings of the ball-circulating type, settings being made to an accuracy of 0·0001 in. by means of an optical scale. The arrangement is such that there is no deflection of the spindle when sideways pressure is applied to the handwheel. An adjustable counterbalance system is provided which ensures easy movement of the quill, and enables the contact pressure between the workpiece and a stylus pin attached to the spindle to be varied down to 8 oz. The spindle nose has a taper bore to take different interchangeable stylus heads.

A Talymin (Taylor, Taylor & Hobson, Ltd.) measuring unit can be provided which gives magnifications of stylus movements from 100 to 5,000 × in six steps. The amplifier is mounted on a platform at the side of the bed, as shown, and there is a second platform on the column to take the dial-type instrument whereby readings are obtained. The stylus head enables bores from 0·1 to 4 in. diameter to be checked.

A microscope, incorporating a setting square, is available, which permits templates and profile shapes, for instance, to be checked in relation to a datum face. A third attachment has a stylus pin with a ½-in. diameter ball end, and is intended for the inspection of aerofoil shapes. Cams and irregular shapes may also be checked on the machine with the aid of an optical dividing head or a rotary table.

As on the jig borer, the 18- by 12-in. work table has a longitudinal movement of 12 in. and a cross travel of 8 in., and settings to an accuracy of 0·001 in. are obtained by leadscrews and corrector bars in conjunction with vernier scales. Rapid power traverse at the rate of 32 in. per min., for coarse setting, is provided by separate push-button controlled motors. A third motor drive gives rapid power adjustment of the column vertically, and a maximum distance of 22½ in. is obtainable between the spindle nose and the T-slotted working surface of the table. The distance between the centre line of the spindle and the column is 10⅝ in.

PRECISIONAIRE AIR GAUGING EQUIPMENT

The exhibits of M.P.J. Gauge & Tool Co., Ltd., Hansons Bridge Road, Erdington, Birmingham 24, afforded an indication of some of the many applications of the Precisionaire range of air gauging equipment which they have recently started to

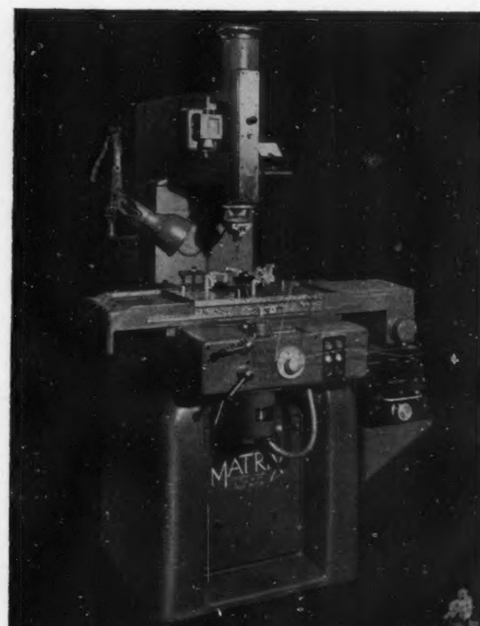


Fig. 1. Matrix 3-dimensional Measuring Machine

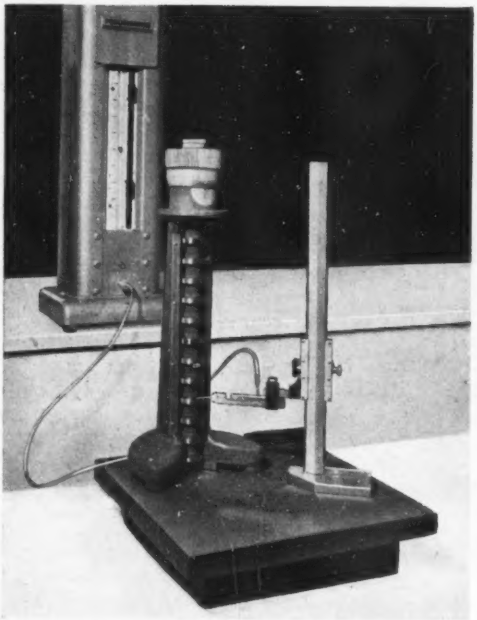


Fig. 2. The Sheffield Airetest Attachment for a Height Gauge is Here Shown Set Up in Conjunction with a Hommel Height Micrometer and a Precisionaire Column-type Indicator Unit

make under licence from the Sheffield Corporation, Dayton, Ohio, U.S.A.

Of particular interest was the new Airetest attachment, shown in Fig. 2 fitted to a height gauge, and set up in conjunction with a German-made Hommel height micrometer (Catmur Machine Tool Corporation, Ltd.). Alternatively, the attachment may be used, for example, on machine tools for checking workpiece bores for concentricity, and on lead testers and gear checkers. Measuring only 4½ in. long by 1 in. wide by ¼ in. thick, the attachment may be connected by flexible hose to a Sheffield indicator unit of the dial type or the Precisionaire column type, as shown, and the latter can be supplied to give magnifications of 1,000, 2,000, 5,000 and 10,000 ×. The contact pressure between the stylus pin and the workpiece is approximately 3 oz. A setting block is provided for calibrating column-type indicator units with magnifications of 1,000 and 2,000 ×, and for adjusting the tolerance pointers. Calibration of indicator units with higher magnifications is carried out with the aid of slip gauges.

The Centrefind centring attachments, which were on view, are available in three designs designated types CF 100, CF 200, and CF 300, and may be used in conjunction with Sheffield dial or column indicator units. The CF 100 attachment, shown on the right-hand side in Fig. 3, has a clip-type mounting sleeve, and the CF 300 unit, seen in the demonstration rig on the left, is intended for use on jig grinders. Intended particularly for use on jig borers, the CF 200 attachment is of similar design to the CF 100, except that the stylus pin is carried in a hinged plate with screw adjustment, to facilitate fine radial setting.

The central portion, which incorporates a connecting piece for the flexible air hose, is prevented from rotating while centring is in progress, and since the indicator units give high magnification, very accurate settings can be made. Another advantage of the attachments is that, because a separate non-moving indicator is employed, readings can be observed conveniently during the entire 360 deg. movement of the stylus pin. Interchangeable stylus pins of different designs can be fitted quickly for checking internal and external surfaces for concentricity, also end faces of the work for squareness. The body of the attachment has a spherical seating to take the ball-shaped upper end of the stylus pin, which is retained by a knurled nut, and can thus swivel freely so that it can be brought into contact with the work.

Reference may also be made to a set-up which was demonstrated for checking workpiece surfaces for flatness. For this application, a Plunjet measuring head, connected to a high-magnification column-type indicator unit, is housed in a bore at the centre of a surface plate, so that its ball shaped

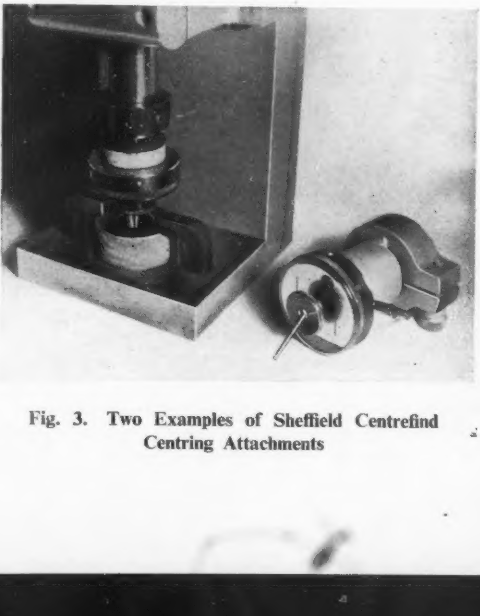


Fig. 3. Two Examples of Sheffield Centrefind Centring Attachments

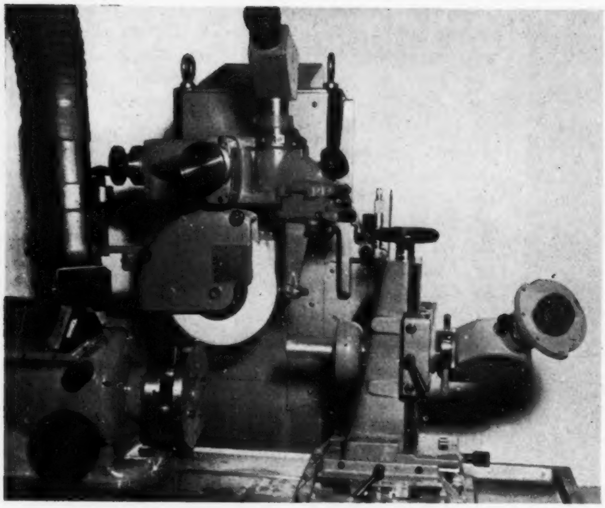


Fig. 4. The "Precision Grinding" Wheel Dressing Attachment is Here Shown Mounted on the Wheelhead of a Jones & Shipman No. 1400 Surface Grinder

end projects slightly above the level of the plate. When a workpiece is passed over the measuring head, while in contact with the plate, any irregularities of surface flatness are shown by movement of the float in the indicator unit.

WHEEL DRESSING ATTACHMENT WITH OPTICAL RADIUS-SETTING FACILITIES

In Fig. 4 is shown a close-up view of a Jones & Shipman No. 1400 surface grinder, the wheelhead of which carries a new diamond dressing attachment introduced by Precision Grinding, Ltd., Mill Green Road, Mitcham, Surrey. On the worktable is mounted the P.G. optical dividing head and Profiloscope equipment, the latter enabling accurate inspection of the work to be carried out while profile shapes are being ground.

This new wheel dressing attachment may also be used on the Jones & Shipman No. 1500 machine, and mounting brackets of different designs can be provided to suit other makes of surface grinders. An arm, which carries the diamond holder, is mounted on a compound slide, and the lower portion can be adjusted towards and away from the centre-line of the wheel by a knob, and secured in the required position by a clamping screw. Accurate settings of the diamond, for convex and concave radii up to ¾-in., are made with reference to a graticule, which is viewed through the eye-piece of a microscope.

The arm and compound slide assembly can be swivelled about the axis of the microscope, and angular movements are controlled by adjustable stops which can be set by means of a scale. When radius-dressing is being carried out, the upper part of the compound slide is held in the central position by two latches, which are swung downwards on each side of a stop pin on the slide. At the end of the swivelling motion, in either direction, one of these latches may be brought clear, and cross movement applied to the slide by a knob through a rack and pinion, for dressing an angular surface on the wheel, tangential with the radius. In this way, the angular portion may be smoothly blended with the radius.

A pair of screw-operated slides carry the microscope and compound slide assembly and it can thus be adjusted parallel with and at right angles to the wheel spindle, to suit grinding wheels with different diameters and face widths. These slides have micrometer adjustment, and the cross travel enables different settings of the diamond holder to be obtained, so that profile shapes can be dressed on fairly wide wheels in a number of stages.

A DIAL INDICATOR SCREW RING GAUGE

Among the exhibits of Tolimit Gauges, Ltd., Peterborough Road, London, S.W.6, was noted the new dial indicator screw ring gauge illustrated in Fig. 5, which enables external threads to be checked for both full form and effective diameter.

The gauging elements comprise two pairs of chaser-type pieces, which are set at right-angles, and are moved radially into and out of the gauging position by a lever-operated cam arrangement. When the lever is set in the central position, as shown, all the gauging elements are brought clear to permit of loading and unloading the workpiece. Movement of the lever in one direction causes the gauging elements for checking threads for full form to be brought into contact with the work. When the lever is swung in the opposite direction, these elements are moved clear, and the second pair is brought into use for gauging the effective diameter. The dial indicator is adjusted for zero with the aid of a setting master. This gauge is available in three sizes for checking threaded parts

up to ¼, from ¼ to ½, and from ½ to ¾ in. diameter, and the elements can be readily changed for others with different thread forms.

AIR-ELECTRONIC MATCHING CONTROL FOR A CYLINDRICAL GRINDER

Another interesting new development by this company is a differential air-electronic matching control system which was demonstrated on a modified Matrix type 1A cylindrical grinder (The Coventry Gauge & Tool Co., Ltd.). With this system, the diameters of male parts are automatically controlled during the grinding cycle, so that a predetermined clearance or interference fit is obtained when they are mated with female parts which may have bores of slightly different diameters.

The machine on which the demonstrations were given had been fitted with a servo motor drive for providing automatic in-feed, also rapid advance and return of the wheelhead at the beginning and the end of the working cycle. A view of the machine, also the cabinet which houses the equipment for controlling the grinding cycle, is given in Fig. 6. On top of the cabinet may be seen, at the right, the plug gauge unit on which the female part is mounted for reference purposes during the grinding cycle, and, at the left, the indicator head, of the liquid column type, for the gauging system.

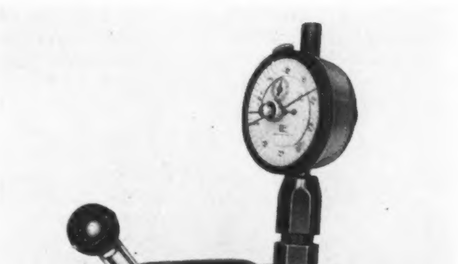


Fig. 5. Tolimit Dial Indicator Screw Ring Gauge

The indicator head is connected by a flexible air hose to a caliper-type sizing attachment carried by the wheelhead, which is swung into engagement with the work, by hand, at the beginning of the grinding cycle.

The head incorporates two photo-transistor units which can be freely adjusted vertically in the body, and the liquid is contained in a transparent tube of triangular cross section. With this arrangement, when the level of the liquid falls below one of the transistor heads, the latter is energized by light rays which are transmitted by a built-in lamp and reflected from the tube.

For setting purposes, one of the female parts from a batch is mounted on the plug gauge unit, a male component, which has been previously ground to give the required clearance or interference fit, is held between the centres on the grinder, and the sizing attachment is swung into engagement with it. Next, a knob on the sizing attachment is adjusted until the level of the liquid in the tube coincides with the bottom edge of the lower photo-transistor unit. The upper photo-transistor unit is then adjusted independently so that the distance between it and the lower unit represents the amount by which the workpiece diameter will be reduced during the spark-out period of the grinding cycle. Since the gauging equipment, on the set-up which was demonstrated, gave a magnification of 7,500 to 1, and reduction of workpiece diameter during the spark out period was of the order of 0·0004 to 0·0005 in., the photo-transistor heads were set several inches apart.

When another female component has been loaded on to the plug gauge unit, and a fresh male part has been placed between the centres, the grinding cycle is started by depression of a push-button on a panel at the front of the bed. Thereupon, the wheel-head is moved, under rapid power traverse, towards the work, and the work-head drive motor is started. At a predetermined point of the wheel-head travel, in-feed is automatically brought into operation, and a signal lamp on the push-button panel is illuminated. During the final stage of the actual grinding cycle, the level of the liquid in the tube falls, and as it moves clear of the upper photo-transistor unit, a signal is transmitted to the control equipment which causes the in-feed motion to be interrupted. Sparking out then proceeds, and when the level of the liquid has fallen until it clears the lower photo-transistor, a second signal is transmitted to the control equipment, with the result that the wheel-head is rapidly traversed away from the work, and the work-head motor is stopped in readiness for unloading the piece. Four coloured signal lamps are mounted

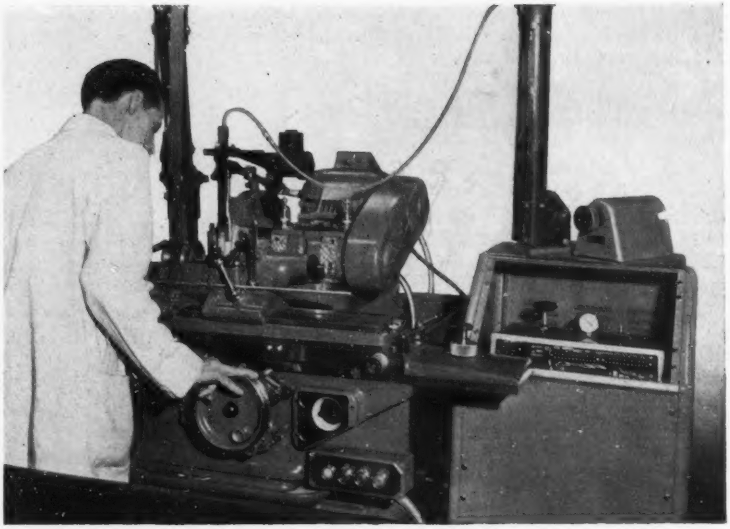


Fig. 6. A Matrix Type 1A Cylindrical Grinder Fitted with the Tolimit Air-electronic Matching Control Equipment

on the side of the indicator head, and are automatically illuminated, in turn, at the beginning of each stage of the grinding cycle.

If required, a third photo-transistor unit can be provided for the indicator, and coarse and fine infeeds for rough and finish grinding, as well as a dwell period for sparking out, can then be obtained automatically.

Air-electronic sizing equipment of similar design, but without the matching control system, was demonstrated on a second modified Matrix machine, which was set up for grinding parts to a predetermined diameter, on an automatic cycle.

Trade Publications

STERN & BELL, LTD., Stour Street, Birmingham, 18. Catalogue listing the wide range of types and sizes of steel which can be supplied from stock.

C.V.A. SMALL TOOLS, LTD., 161 Victoria Street, London S.W.1.—Leaflet describing the C.V.A. Electro-Etch marking pencil which is employed with a special tungsten needle. Three thicknesses of writing can be obtained by voltage adjustment.

SOAG MACHINE TOOLS, LTD., Juxon Street, Lambeth, London, S.E.11.—Stock list covering an extensive range of machine tools many of which have been rebuilt to Schlesinger limits. Machines are conveniently classified for ease of reference, and brief particulars are included for each item. Representative examples are illustrated.

JOSEPH BATSON & CO., LTD., Tiptone Works, Tipton, Staffs.—Folders concerned with the company's Tiptone Dielubes for use in connection with hot or cold metal working operations such as deep drawing, extrusion, die casting and forging, also with equipment for dispensing these lubricants. The latter includes self-contained automatic units which are supplied to suit particular machines, also hand-operated guns.

CREED & CO., LTD., Telegraph House, Croydon, Surrey. Illustrated folder No. DP.2, describing the type 25 high-speed re-perforator which is the latest addition to the company's range of tape-punching equipment. There are two versions of this unit, one for punching 6- and 7-track tapes, and the other for the standard 5-track tape. This re-perforator may be used in conjunction with a digital computer; as an output tape-punch for a variety of office machines; and for automatic recording applications.

W. CHRISTIE & GREY, LTD., 4 Lloyds Avenue, London, E.C.3. Illustrated booklet, No. 957, dealing with the wide range of vibration isolating equipment made by the company. Photographs of typical industrial applications are given, and a section is devoted to the fundamental theory of the isolation of vibration in its two forms—free and forced. Details are given of steel spring and rubber unit mountings; rubber, cork, cork-rubber, and felt isolating materials; and steel spring suspension mountings for the isolation of concrete foundation blocks and bases.

KLAXON, LTD., 49 Upper Brook Street, London, W.1. Fully-illustrated publication covering Klaxon motors which are available in various types and in numerous capacities from 1/100 to 1 h.p. A separate brochure is devoted to geared motors which are offered with a wide choice of arrangements and speeds. In addition, a recently issued loose-leaf catalogue is concerned with such products as instrument motors, shaded pole motors, ironclad and flameproof signals, industrial motor-driven hooters, and industrial buzzers.

News of the Industry

Manchester and District

CONDITIONS UNCHANGED AT THE FOUNDRIES.—Foundry trade conditions in the Lancashire area continue more or less unchanged. Localized under-employment persists, and as reduced amounts of overtime are being worked, there is no great pressure upon the Midland blast-furnaces for pig-iron supplies. At the same time, fresh business continues to be confined to orders for delivery in the near future. There has been no change in the quotations for pig-iron and haematite iron, and demand for the latter material is quietly steady. Moderate buying interest is reported in the various grades of finished iron materials.

SLOWING DOWN OF STEEL DEMAND.—For most descriptions of steel materials, less pressure for supplies is reported. Heavy steel plates continue to be the most active section, followed by large-diameter mild steel bars, special alloy steels and semi-finished materials for the forges and wire-drawing industry. The heavy electrical engineering and heavy machine tool industries are among the principal buyers of steel products.

B. & S. MASSEY, LTD., Openshaw, are experiencing a good demand for a wide variety of steam and pneumatic hammers and presses, from customers at home, in the Commonwealth and on the Continent. Orders have been received from both home and overseas railway companies. Work in progress includes steam hammers of various capacities; Clear-space type pneumatic hammers, with hand and foot control; large high-speed forging presses for the mass production of close-limit die-forgings; Marathon automatic drop hammers for the mass production of drop forgings to close limits; batteries of friction drop hammers and double-acting drop hammers; trimming presses; and tyre fixing rolls for securing the retaining rings in tyres of railway locomotive, carriage and wagon wheels. Since our last visit, various additions have been made to plant, and a new machine shop is at present in course of erection.

ENGLISH STEEL TOOL CORPORATION, LTD., North Street Works, Openshaw, are well employed on the production of a wide range of engineers' cutting tools, including taps, dies and chasers; twist drills and sockets; centre- and slot-drills; gear cutters and hobs; broaches; hand, machine and adjustable machine reamers; milling cutters; side and face cutters; slotting cutters; slitting saws; end mills; lathe tools; and boring cutters; as well as special cutters of various types. Our attention was drawn to the new blank preparation department which is being established for concentrating on the rapid machining of the blanks of all types of shank tools. In addition to copy-turning lathes, the company has installed a Wickman 6-spindle, 1-in. capacity, bar automatic and two special machines for squaring and coning the ends of drill blanks. It is hoped to make further reference to this new department in due course.

RELIANCE GEAR & ENGINEERING CO. (SALFORD), LTD., Dickinson Street, Salford, still find it necessary to work overtime in order to meet the big demand for all types of gear-cutting. Considerable reorganization and building extensions have been carried out at these works further to facilitate production. An increasing demand for precision gears is reported and we may note the recent completion of a number of intermittent spur gears. Among the recent additions to plant are a Sykes 3C gear generator for spur gears up to 40 in. diameter by 3 D.P., a Parkinson Sunderland No. 19 double-helical gear planing machine of 56-in. diameter capacity, and a Gleason Coniflex No. 24A straight bevel gear generator for gears up to 36 in. diameter by 1 D.P.

DAVID BROWN INDUSTRIES, LTD., JACKSON DIVISION, Salford, recently produced a cast steel spur gear of 25 ft. 10 in. diameter and weighing nearly 25 tons, for driving the largest Aerofall ball mill yet made. This mill is being built by Harland & Wolff, Ltd., Glasgow, to the order of Aerofall Mills, Ltd., Toronto, Canada, and will be installed at the Sinoia copper mine of Mangula, Ltd., Southern Rhodesia, where it will be used for breaking copper ore. It weighs 225 tons, and is driven by a 1,250-h.p. motor, to give a mill speed of 14·1 r.p.m. The gear was cast in four sections, each weighing 7½ tons as cast. On the 20 in. face were cut 308 teeth of 1 D.P., and a forged steel driving pinion with 29 teeth was also supplied. At the mine, the mill will reduce 100 to 200 tons of ore to a size suitable for smelting in one operation. The ore is carried to the highest point inside the mill on projecting arms, and crushing is effected by impact when the ore falls to the

base, the broken pieces then being ground by rotary action. Automatic removal of the ground material when it reaches a predetermined size is effected by blowing a controlled air blast through the drum.

CRAVEN BROTHERS (MANCHESTER), LTD., Reddish, Stockport, have recently built a special double-headed horizontal boring machine for Lancashire Dynamo & Crypto, Ltd., Trafford Park, Manchester, for boring, facing and grooving operations on electrical stator casings. The work is held stationary on a central table while the machining operations are carried out on both ends simultaneously by right-hand and left-hand headstocks. These three units are adjustably mounted on a heavy box-type, 2-shear bed. Each head is driven by a 7-h.p. motor and 12-speed gearbox mounted at the end of the bed, and the spindle speeds range from 6 to 120 r.p.m. Longitudinal feeds for boring range from 0·08 to 0·0133 in. per rev., and facing feeds from 0·030 to 0·005 in. per rev. The work table has a T-slotted surface measuring 24 by 42 in., and the height from the table top to the spindle axis is 15 in.

Each headstock has a longitudinal traverse of 33 in. on the bed, and the facing slide has a radial traverse of 7 in. It is hoped to describe this machine more fully at a later date. H. B.

General View of the New Precision Casting Foundry of Samuel Osborn & Co., Ltd.

Osborn's Precision Castings Foundry

Samuel Osborn & Co., Ltd., Clyde Steel Works, Sheffield, have purchased 73 acres of land on the Holbrook Industrial Estate, at Halfway, 7 miles from the centre of Sheffield. This land is intended for future developments, and, recently, a visit was arranged to the new precision castings foundry that has been erected on the site. The foundry is now engaged in the production of Socast steel castings, and is operated as a subsidiary company, under the title Osborn Precision Castings, Ltd. Socast steel castings are produced by precision moulding techniques developed by the parent firm, which include the shell moulding, Osborn Shaw and Osborn CO_2 block processes.

A general view of the new foundry is given in the accompanying figure, and the buildings are arranged in two long bays, each 200 ft. long by 50 ft. wide, with a 30-ft. wide service annexe of the same length. One of the larger bays is devoted to melting and casting, also the production of moulds and cores, and fettling, heat treatment and scrap storage are confined to the second bay. As many different grades of steel are melted, provision has been made for the effective segregation of scrap. Melting capacity is provided by three Birlec 5-cwt. and one 1-cwt. high-frequency furnaces, powered by two 200-kVA. generators. Factory heating is provided by an oil-fired high-pressure hot-water system, and forced draught ventilation gives 10 changes of air per hour. In the service annexe are works' offices, laboratories, pattern shop, pattern store and boiler room, and an administration block houses offices, canteen, rest room and washing facilities for all employees.

Prior to the visit to the foundry, a luncheon was served at the Royal Victoria Station Hotel, Sheffield. Visitors were welcomed by Mr. Frank A. Hurst, chairman and managing director of the company, and Sir Frederick Pickworth, Master Cutler, and Mr. R. S. Fearnehough, President of the Sheffield Chamber of Commerce, also spoke. A colour film of the new factory at work was shown and commented upon by Mr. J. H. Osborn, director.

Castings are being produced with weights ranging from a few ounces to 30 or 40 lb., in carbon steel, 13/14 per cent manganese steel, low-alloy and high-alloy steels. Complex shapes are produced which need the minimum of machining, and replace components hitherto machined from the solid, or from forgings, or sand castings.

New Laboratories for P.E.R.A.

The new workshops and laboratory block occupied some months ago by P.E.R.A. (Production Engineering Research Association of Great Britain), at Melton Mowbray, Leicestershire, were formally opened recently by Lord Chandos, chairman of the Associated Electrical Industries group of companies.

Built at a cost of £250,000, the new block provides some 45,000 sq. ft. of floor space, and the equipment it houses, much of which has been transferred from other buildings, is valued at about £500,000. A view of the new building is given in Fig. 1. The workshops, in which most of the research work undertaken by the Association on production methods in the metalworking industries is carried out, occupy a considerable part of the building. They have a floor area of 20,000 sq. ft., and incorporate a self-contained department equipped for investigating cutting tool life by means of radioactive tool tips. Another part of the workshops is devoted to research work associated with the effects of vibration on machines and cutting tools. Here, the shop floor comprises a number of separate sections which are insulated from each other, and the surrounding area, to eliminate the effects of vibration from adjacent machines. Current research on the impact extrusion of steel and non-ferrous metals covers investigations into the properties of workpiece materials, slug lubrication and variations in extrusion pressure with percentage reduction in area, and to permit this work to be carried out on fairly large components, a Clearing (Rockwell Machine Tool Co., Ltd.) 100-ton single-action eccentric press has been installed.

Fig. 1 (above). A View of the New P.E.R.A. Workshop and Laboratory Building which Provides an Area of Some 45,000 sq. ft. Including 20,000 sq. ft. of Workshop Space. Fig. 2 (below). A View of the Metrology Laboratory which has a Specially Insulated Floor

Adjoining the main workshops, there is a machine tool laboratory, with a floor area of 1,150 sq. ft., where investigations into various aspects of slideway lubrication are being undertaken. A report is being prepared on the influence of different types of bearing surfaces, lubricant viscosity, load per unit area, and sliding speed, on the transition from boundary to hydro-dynamic lubrication. Practical tests are also being carried out to determine the frictional properties of various lubricants and machine tool slideway materials.

In Fig. 2 is shown a view of the well-equipped metrology laboratory, which has a floor area of 3,200 sq. ft. Between the foundations and the 1-in. thick concrete floor which is faced with wood blocks, there is a 1-in. thick glass fibre blanket, and with this construction, the risk of vibrations being transmitted from the adjoining workshops is reduced. The glass fibre blanket extends round the edges of the floor, which is thus insulated from the walls. Other facilities provided in the new building include metallurgical laboratories equipped for metallography and chemical analysis, an electronics laboratory and drawing and administrative offices.

At present, there are 640 member companies of the Association, who are engaged in the manufacture of a wide variety of products. In addition to general investigations, approximately 1,200 special problems have been examined for individual member firms, and some aspects of this work were considered in an article in MACHINERY, 92/277—31/1/58.

Fawcett Preston Bi-Centenary

To celebrate the bi-centenary of Fawcett Preston & Co., Ltd., Bromborough, Cheshire, a member firm of the Metal Industries Group, there was a large gathering of distinguished visitors at a luncheon held at Hulme Hall, Port Sunlight, on Thursday, June 5. After the loyal toast, the Lord Mayor of Liverpool, Alderman Harry Livermoor, J.P., proposed "Fawcett Preston & Company," to which Sir Charles Westlake, chairman of Metal Industries, Limited, and of Fawcett Preston & Co., Ltd., responded. Sir Charles then proposed a toast to the guests, and Mr. Hendrie Oakshott, M.B.E., M.P., responded.

To mark the occasion, an engraved silver salver was presented to the Corporation of Bebington by Mr. Leslie Davies, managing director of Fawcett Preston & Co., Ltd., and this was accepted by His Worship the Mayor of Bebington, Councillor S. F. Williams, J.P. The presentation of a painting of the paddle steamer *William Fawcett* was made to Fawcett Preston & Co. by Sir John Hathorn Hall, G.C.M.G., D.S.O., O.B.E., M.C , a director of the P. & O. Steamship Co., Ltd., and this was accepted by Mr. Wilfred Padley, C.M.G., O.B.E., deputy chairman, on behalf of the company.

After the luncheon there were conducted tours of the factory and of the exhibition "Fawcett, Past and Present." A well-produced and liberally illustrated souvenir handbook, entitled "Fossets," has also been issued, in which the history of the company and its engineering activities during the past two hundred years are recorded.

Precision Sand Casting

(*Continued from page* 1371)

actual relationships have not yet been accurately established. Surface finish of Alphax castings is necessarily somewhat inferior to that obtainable by the investment processes, but it is said to be adequate for the majority of applications, particularly where larger parts are involved. The principal merit claimed for the process, however, is the assurance of metallurgical soundness, which will enable designers to specify castings with confidence for an increasing range of purposes.

Certainly this process appears to represent an important advance in a field where progress can yield results of great benefit to the metal working industries as a whole. What is particularly significant, however, is the author's remark that in this work he "can only see the beginning, for after all there is nothing particularly new about the process, unless it is the selective use of materials and adherence to sound principles in the manufacture and use of moulds."

Personal

MR. M. O. L. LYNTON has been appointed a director of Soag Machine Tools, Ltd., 7 Juxon Street, London, S.E.11.

MR. P. B. WARD has been appointed sales manager of Technical Designs, Ltd., 46 Brook Street, London, W.1. He formerly held a similar position with Danite Hard Metals, Ltd., Doncaster.

DR. W. D. SUTHERLAND, B.Sc., Ph.D., A.M.I.E.E., has been appointed chief engineer (electrical) to C.A.V., Ltd., Warple Way, Acton Vale, London, W.3. He joined the company in 1954, as product development engineer (electrical), and was responsible for the development of the C.A.V. automatic gear change control equipment.

DR. L. W. BROWN, B.Sc., Ph.D., M.I.E.E., F.Inst.P., has been appointed assistant chief electrical engineer (light current) of the Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester. Dr. Brown, who joined the company in 1950, will retain his position as chief engineer of the electronics department, which he has held since its inception in 1955.

Machine Tool Trades Association

It is announced that Mr. W. J. Morgan, M.B.E., will retire from his appointment as general manager of the Machine Tool Trades Association on June 30. He joined the Association as secretary in July, 1939, after service with the Board of Trade and as technical adviser to the Import Duties Advisory Committee, and was made general manager in December, 1950. These two positions he has filled with distinction, and we are pleased to state that he is not completely severing his connection with the Association, his services having been retained in the non-executive capacity of adviser from the date of his retirement.

Mr. W. J. Morgan

On July 1, Mr. H. O. Barrett, to whom we offer our congratulations and good wishes, will assume the overall responsibility for Association affairs.

Mr. Guy Chesham, whilst continuing his responsibilities as public relations officer, will also be concerned with the Association's European and other overseas activities.

North London E.I.A. Luncheon Meeting

The North London Group of the Engineering Industries Association recently held a luncheon meeting which was attended by 40 representatives of member firms. A talk was given by a guest speaker, Mr. K. R. Sandiford, B.Sc., chief instrument engineer of the U.K.A.E.A., on the development of nuclear power plant and the use of special instruments associated with reactors and other apparatus. Reference was also made to the types of instruments used for detecting radioactive isotopes.

Correction

In MACHINERY, 92/1361—6/6/58 reference was made to the new premises of J. E. Baty & Co., Ltd., at Burgess Hill, Sussex. It was inadvertently stated that these premises provide more than 2,000 sq. ft. of production space, whereas the space available for this purpose is, in fact, 20,000 sq. ft. We are asked to point out that the company's London office at 39 Victoria Street, S.W.1, is still in operation for telephone enquiries, etc., and that stocks are carried at this address for urgent delivery.

Bronx Press Brake Sound Film

A new 16-mm. sound film, entitled "The Adaptable Giant," was made recently by Saga Services, Birmingham, for the Bronx Engineering Co., Ltd., Lye, Worcestershire. This film, which runs for 20 min., illustrates several applications of Bronx press brakes ranging in capacity from 20 to 750 tons. The largest machine shown in the film is set up to bend ¾-in. high carbon steel plate used in the construction of bodies for earth-moving vehicles. Other press brakes are shown producing switchgear cabinets, refrigerator panels, and parts for business machines. Several interesting tools are used for these bending operations, and in this connection it may be noted that Bronx Engineering provide a tool design service for users of all types of press brakes. Copies of the film may be obtained, on loan, from Bronx Engineering Co., Ltd.

Tightening and Tensile Tests on Joints

(*continued from p.* 1394)

a maximum at the bearing end to practically zero at the free end. Measurements across the flats of ¾-in. and 1½-in. nuts after test showed that the maximum nut expansion, expressed as a percentage of initial depth of engagement, was greatest for UNF in both sizes, and averaged about 40 per cent. A similar result was obtained for those 1½-8.BSF nuts which had stripped, but in all other cases the values obtained averaged about 10 to 20 per cent.

Industrial Notes

Wild-Barfield Electric Furnaces, Ltd., Elecfurn Works, Otterspool Way, Watford By-Pass, Watford, inform us that the address of their branch office in Canada has been changed to 77 Grenville Street, Toronto, Ontario.

George Kent, Ltd., Biscot Road, Luton, Beds., inform us that they are to open a branch office at Westparkstrasse, 54, Krefeld, Germany, with a comprehensive spares and service department for the complete range of their products.

Motor Car Production in April fell to 81,255 cars, against 87,406 in March. Exports were reduced to 38,586, but this total was nearly 4,000 greater than that for April last year.

Aircraft Industry Exports for the first four months of this year reached the record total of £50,257,246, which was over 50 per cent higher than in the same period of 1957, according to the Society of British Aircraft Constructors.

An Auction Sale of Machine Tools and miscellaneous stores from the Technical Stores Sub-Depot, Old Dalby, Melton Mowbray, Leics., will be held on July 2. The auctioneers will be Shouler & Son (Dept. N), 1 Norman Street, Melton Mowbray. Leics.

Kelvin & Hughes (Industrial), Ltd., inform us that a specially-built demonstration unit has been despatched on a 4-month tour of Eastern Europe, and will visit Poland, Czechoslovakia, Hungary, Rumania, and Yugoslavia. Among the equipment which is being displayed are the Mk. 5 and 6 ultrasonic flaw-detection units, and a model of the Mk. 2 automatic flaw detector, complete with C.R.T. trace and pen recorder.

Production of Iron Castings.—The total output of iron castings in the first quarter of 1958, at 961,000 tons, was virtually the same as in the previous quarter, and as in the first quarter of 1957. The requirements of the motor-car industry and railways showed an increase, as compared with the earlier quarters, but this was offset by a decline in the engineering, building and domestic demands.

Ajax Engineering Co. (Technical Division), 6/7 Kildare Close, Field End Road, Eastcote, Ruislip, Middlesex, announce that they will shortly be offering a microfilming service for the copying of documents and plans, for example. Copying will be carried out on 8, 16, and 35 mm. film, according to the size of the original material, and, for drawing office work, the company anticipate installing 70-mm. film equipment in the future.

G.T.M.A. Export Catalogue.—Reference to the fourth edition of this catalogue was made in Machinery, 92/1250—23/5/58. We are asked by The Gauge and Tool Makers' Association, Standbrook House, Old Bond Street, London, W.1, to point out that copies are available, free of charge, to all overseas buyers, and may be obtained by British firms and agencies on remittance of the cost of postage (8d.).

King's College, Newcastle-on-Tyne.—Extensions to the metallurgy department of the College were officially opened recently by Mr. C. Cookson, chairman of the Consett Iron Co., Ltd. In his speech, Mr. Cookson referred to the need for closer co-operation between industry and the science departments of universities, and to the fact that, as the methods of processing steel became more complex, so would the demand for trained metallurgists increase.

Films on Materials Handling.—The National Joint Committee on Materials Handling, 20-21 Took's Court, Cursitor Street, London, E.C.4, a co-ordinating committee for professional and other bodies interested in materials handling, particularly from an educational standpoint, has compiled a list of films on this subject which will be supplied, upon receipt of a stamped addressed envelope, by The Secretariat at the above address. Some sixty titles are listed, and the size and running time (where known) are given, also the source of film and a brief synopsis of its purpose and audience suitability.

The Birmingham Engineering Centre, Stephenson Place, Birmingham, 2, in conjunction with, and on behalf of, the Board of Trade, will organize the British Engineering exhibit at the National Industrial Production Show of Canada, to be held in Toronto from May 4 to 8, 1959. This exhibition, which is held biennially, affords an opportunity for displaying all types of production equipment, and firms interested in acquiring stand space, which will be available in units of 120 sq. ft., or possibly less, should communicate with the general manager, Mr. A. J. Cox, at the above address.

Frank Whitelegg, Ltd., 304 High Street, Sutton' Surrey, inform us that Emil Schenker A.-G., Schönenwerd' Switzerland, for whom they are sole agents, have developed special tooling for their type FA-1 automatic high-speed spring coiler. This machine, which has a capacity for wire from 38 to 19 s.w.g., and will produce coils up to 0.6 in. diameter, can now be employed for the production of single layer resistance and choke coils from copper wire and similar materials. High outputs are obtainable, and it is claimed that this method enables important economies to be effected as compared with the alternative of coiling on mandrels.

The Industrial Fuel Efficiency Exhibition will be held at Olympia from September 24 to October 3, and the organizers, Provincial Exhibitions, Ltd., City Hall, Deansgate, Manchester, report that a wide variety of improved plant and equipment will be on show. The exhibits will range from conventional solid fuel appliances, to gas, oil, electric, and nuclear power plants, and there will be examples of the latest techniques in automatic control and instruments. A series of technical conferences has also been arranged, by the Institute of Fuel, and enquiries for details of these conferences, and for stand space, should be sent to the above address.

BRITISH MONORAIL, LTD., manufacturers of overhead lifting gear, are transferring their entire works from Chadderton, Oldham, to premises in Wakefield Road, Brighouse, Yorks., which were formerly occupied by Cengar, Ltd. The company, which was formed in 1952, was reorganized last year, with Mr. James Dallas, as chairman and managing director, and business has since more than doubled. At present there are 180 employees, and it is expected that the number will increase to 500 during the next three years. Twenty per cent of the capital is held by the American Monorail Company, whose wide experience in mechanical handling is at the disposal of the British firm.

THE L. S. STARRETT CO., LTD., it is reported, has been formed as a subsidiary of The L. S. Starrett Co., Athol, Massachusetts, U.S.A., to produce precision tools, hacksaws, and handsaws in Scotland. We are informed that a £270,000 factory is to be built for the new company at Hartrigge, Jedburgh, by the Roxburgh County Council, and it is hoped that production will begin in 1959. The company is recruiting for key posts and selected men will receive a year's training with the parent firm in the U.S.A. It is stated that 100 people will be employed initially, and that the number will subsequently be increased to 250. As European trade increases substantial expansion may be necessary.

LANDIS MACHINE-MAIDEN, LTD., Hyde, Cheshire.—It is announced that the Landis Machine Co., of Waynesboro, U.S.A., and Maiden & Co., Ltd., Cheshire, have amalgamated to form a new British company with the above title. The products of these firms are complementary, and while the new company will continue to build threading machines in the existing Maiden range, the scope of its activities will be widened to include the manufacture of tangential thread chasers and certain other Landis products. The area of the existing factory at Hyde, Cheshire, will be extended by a further 15,000 sq. ft., and, initially, additional plant and equipment will be installed for the production of tangential thread chasers.

CHARLES CHURCHILL & CO., LTD., Coventry Road, South Yardley, Birmingham, have recently been appointed the sole selling agents in the United Kingdom for a number of machines from the range built by Ernst Grob, Munich, Germany. These machines include the types RM0a and RM40d thread rolling machines, the latter being intended for long threading operations by either the in-feed or through-feed process, or a combination of both. Other machines in the Grob range include fully-automatic, electro-hydraulic, milling and centring machines, and a number of special-purpose machines which incorporate unit heads for milling, drilling, tapping, boring, and facing operations. These special machines are built to customers' requirements, and can be equipped for automatic loading and unloading, if required.

AN EXHIBITION OF FOREST MACHINERY held recently at Blackbushe Airport, Bramshill, Surrey, by the Forestry Commission, 25 Savile Row, London, W.1, served to draw attention to the wide variety of mechanized cultivating, drain-cutting, earth-moving, and sawing equipment, for example, for use in connection with estate forestry. Among the 70 exhibitors was E. P. Barrus, Ltd., 12 Brunel Road, London, W.3, who displayed the Blackhawk Featherweight hydraulic pipe bender of 2 in. capacity. This company also showed examples of the use of Devcon " plastic steel " for repairing cracked castings. Holman Brothers, Ltd., Camborne, Cornwall, showed the Goodyear pump, which was described in MACHINERY, 92/455—21/2/58, and the Tractair portable compressor. The latter is intended for mounting on tractors such as the Fordson Major.

Scrap Metals

†LONDON.—‡Prices per ton for non-ferrous scrap metals free from iron are as follows:—clean copper wire, untinned and free from lead and solder, £145; clean heavy copper, untinned and free from lead and solder, £140; second grade copper wire, £135; clean light copper, £130; braziery copper, £117; gunmetal, £121; brass mixed, £87; lead, net, £58; zinc, £28; cast aluminium, £82; old rolled aluminium £110; battery lead, £31; unsweated brass radiators, £70; hollow pewter, £495; black pewter, £365

MIDLANDS.—The difficulties of moving all grades of processed scrap to steelworks, blast furnaces and foundries has not eased during the past two weeks. Limited tonnages of scrap can be placed, against allocations, but far more processed scrap is in circulation in the Midlands than can be delivered, and, consequently, stocks in merchants' yards are excessively large.

Such grades as " bushy " turnings, light iron, and destructor scrap cannot be cleared regularly, and even though factories are prepared to accept very low prices for such scrap, few collections are being made.

Heavy steel scrap No. 2, which normally is delivered from merchants' yards every day, is hard to place in anything like the available quantities and yard men are preparing scrap for stock, against the day when normal trading is resumed. Steel turnings of a shovellable or chipped nature are moving more regularly, but more outlets are still required to absorb all supplies from local factories. The demand for borings is variable, and reduced prices are being offered under new contracts.

Compressed destructor bales are being produced in excess of market demand, and many tons are in stock at merchants' yards.

Odd parcels of scrap, offered by many builders and contractors, for example, cannot be handled, as the smaller scrap firms cannot obtain allocations for delivery.

Foundry trading in short steel and cast iron is very quiet.

Current maximum control prices, delivered consumers' works, are now: *Heavy steel No. 1, 217s. 6d.; *heavy steel No. 2, 196s.; *heavy steel No. 4, 207s. 6d.; *heavy steel No. 5, 195s. 6d.; light iron No. 8, 149s.; short turnings No. 9 (free from alloy), 167s. 3d.; light steel No. 11, 164s. 3d.; bushy turnings, 117s.; short alloy turnings, 160s. 9d.; short steel No. 2, 233s. 3d.; machinery cast, 233s.

Prices may be increased up to 2s. 6d. per ton according to quantities tendered over a given period.

* For use by Round Oak Steelworks, Brierley Hill, increase by 1s. 6d. per ton.

† George Cohen, Sons & Co., Ltd., 600 Commercial Road, E.14.

‡ Subject to market fluctuations.

Machine Tool Share Market

Quiet conditions prevailed on the Stock Exchange during the past week, but markets, as a whole, displayed a firm tone for the most part.

The gilt-edged section met with moderate but sustained investment support, and quotations of British Funds and kindred stocks steadily appreciated and finished at the highest levels.

Activity in the commercial and industrial sections remained at a low level, but a satisfactory tone was maintained, with the majority of price changes slightly higher on balance.

Among machine tool issues, Armstrong Stevens advanced 1½d. to 8s.; Samuel Osborn, 3d. to 17s.; Ambrose Shardlow, 4s. 6d. to 37s. 6d.; John Shaw & Sons (Wolverhampton), 1½d. to 12s. 4½d.; and Thos. W. Ward, 7½d. to 74s. 4½d. On the other hand, Asquith Machine Tool lost 7½d. at 18s. 1½d.; Alfred Herbert, 7½d. at 32s. 6d.; Noble & Lund, 3d. at 2s. 9d.; Modern Engineering, 6d. at 8s. 6d.; and Scottish Machine Tool, 9d. at 4s. 6d.

KITCHEN & WADE, LTD. Second interim dividend of 8⅜ per cent, plus a bonus of 4⅛ per cent, making a total distribution of 20⅝ per cent for the year ended March 31, last (same).

AMBROSE SHARDLOW & CO., LTD. Final dividend of 10½ per cent, making, with the interim, a total distribution of 15 per cent for the year to March 31, last, an increase of 2½ per cent as compared with the total for the preceding year.

New Companies Registered*

PARAMATTA TOOL & GAUGE CO., LTD., Blucher Street, Salford, 5. Registered May 13, 1958. Nominal capital: £5,000 in £1 shares. Directors: B. P. Sweeney and P. Grayson.

MURRAY ENGINEERING CO. (HAYES), LTD., 2 Finchley Road, London, N.W.8. Registered May 1, 1958. To take over the business of tool makers carried on at Printing House Lane, Hayes, Middlesex, by J. R. and A. P. Bell, etc. Nominal capital: £5,000 in £1 shares. Directors: John R. Bell and A. P. Bell.

S.W.F. MANUFACTURING CO., LTD., 42/52 Garrison Lane, Birmingham. Registered May 20, 1958. To take over the business of "S.W.F. Press Tool Company" carried on at Birmingham by Wilfred I. Fowler and Albert Simmons, etc. Nominal capital: £15,000 in £1 shares. Directors: W. I. Fowler, A. Simmons and W. C. Fowler.

* From the lists compiled by Jordan & Sons, Ltd., Company Registration Agents. 116-118 Chancery Lane, London, W.C.2.

COMPANY		Denom.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	9d.
Armstrong, Stevens & Son, Ltd.	Ord.	5/-	8/-
Allen (Edgar) & Co., Ltd.	Ord.	£1	27/-
,, ,,	5% Prf.	£1	14/9*
Arnott & Harrison, Ltd.	Ord.	4/-	13/9xd
Asquith Machine Tools Corp., Ltd.	Ord.	5/-	18/1½
,, ,, ,,	6% Cum. Prf.	£1	18/6xd
Birmingham Small Arms Co., Ltd.	Ord.	£1	28/3xd
,, ,, ,,	5% Cum. "A" Prf.	£1	15/6
,, ,, ,,	6% Cum. "B" Prf.	£1	17/6
,, ,, ,,	4% 1st Mort. Deb.	Stk.	85/-xd
British Oxygen Co., Ltd.	Ord.	£1	34/6
,, ,, ,,	6½% Cum. Prf.	£1	21/3xd
Brooke Tool Manufacturing Co., Ltd.	Ord.	5/-	4/7½
Broom & Wade, Ltd.	Ord.	5/-	10/4½
,, ,,	6% Cum. Prf.	£1	17/9
Brown (David) Corporation Ltd.	5½% Cum. Prf.	£1	14/-
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	17/9xd
Butler Machine Tool Co., Ltd.	Ord.	5/-	5/6
,, ,, ,,	5% Cum. Prf.	£1	13/9
C.V.A. Jigs, Moulds & Tools, Ltd.	5½% Red. Cum. Prf.	£1	13/9
Churchill (Charles) & Co., Ltd.	Ord.	2/-	4/4½xd
,, ,, ,,	6% Cum. Prf.	£1	26/3
Churchill Machine Tool Co., Ltd.	Ord.	5/-	17/6
,, ,, ,,	6% Cum. Prf.	£1	18/6
Clarkson (Engrs.), Ltd.	Ord.	5/-	12/3
Cohen (George), Son & Co., Ltd.	Ord.	5/-	11/10½
,, ,, ,, ,,	4½% Cum. Prf.	£1	14/6
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	13/9
,, ,, ,, ,,	5% Cum. Red. Prf.	£1	16/3
Coventry Machine Tool Works, Ltd.	Ord.	4/-	8/9
Craven Bros. (Manchester), Ltd.	Ord.	5/-	6/7½
Elliott (B.) & Co., Ltd.	Ord.	1/-	3/-
,, ,,	4½% Red. Cum. Prf.	£1	13/9xd
Export Tool & Case Hardening Co., Ltd.	Ord.	2/-	1/3
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	12/-
Greenwood & Batley, Ltd.	Ord.	£1	46/10½

COMPANY		Denom.	Middle Price
Harper (John) & Co., Ltd.	Ord.	5/-	13/7½
,, ,,	4½% Red. Cum Prf.	£1	13/1½
Herbert (Alfred), Ltd.	Ord.	£1	32/6
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	10/3
,, ,, ,,	"B" Ord.	5/-	9/9
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	21/3
,, ,, ,,	7% Cum. Prf.	5/-	5/-xd
Kayser, Ellison & Co., Ltd.	Ord.	£1	44/6
,, ,, ,,	6% Cum. Prf.	£1	18/3
Kendall & Gent, Ltd.	Ord.	5/-	7/9
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	6/3
Kitchen & Wade, Ltd.	Ord.	4/-	10/-
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/4½
Massey, B. & S., Ltd.	Ord.	5/-	7/9
Modern Engineering Machine Tools Ltd.	Ord.	5/-	8/6
Newall Engineering Co., Ltd.	Ord.	2/-	*4/6
Newman Industries, Ltd.	Ord.	2/-	2/3
,, ,, ,,	6% Prf. Ord.	5/-	5/6
Noble & Lund, Ltd.	Ord.	2/-	2/9
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	Exrights 17/-
,, ,, ,,	5½% Cum. Prf.	£1	25/3
Pratt (F.) & Co., Ltd.	Ord.	5/-	21/3
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	4/6
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	37/6
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	12/4½
Sheffield Twist Drill & Steel Co., Ltd.	Ord.	4/-	33/9xd
,, ,, ,, ,,	5% Cum. Prf.	£1	15/-xd
Stedall & Co., Ltd.	Ord.	5/-	6/3
Tap & Die Corporation, Ltd.	Ord.	5/-	7/6
,, ,, ,,	4½% Deb. 1961-1977	Stk.	82/-
Wadkin, Ltd.	Ord.	10/-	18/9
Ward (Thos. W.), Ltd.	Ord.	£1	74/4½
,, ,,	5% Cum. 1st Prf.	£1	15/9
,, ,,	5% Cum. 2nd Prf.	£1	25/-
Willson Lathes, Ltd.	Ord.	1/-	2/4½

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Birmingham price.

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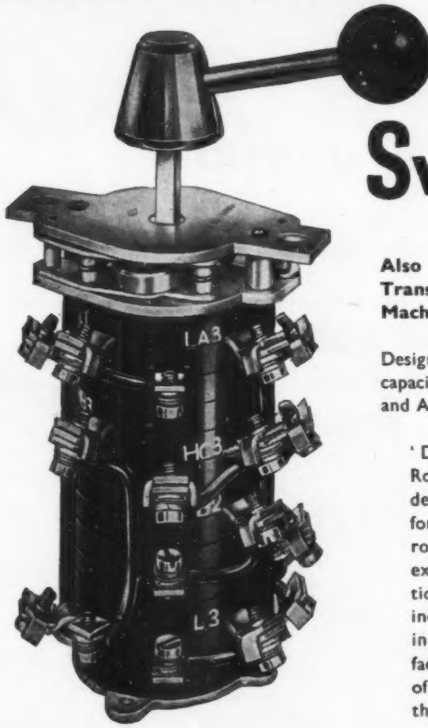

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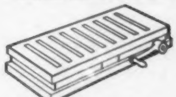

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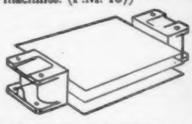

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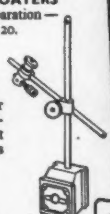

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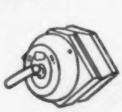

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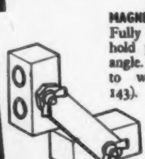

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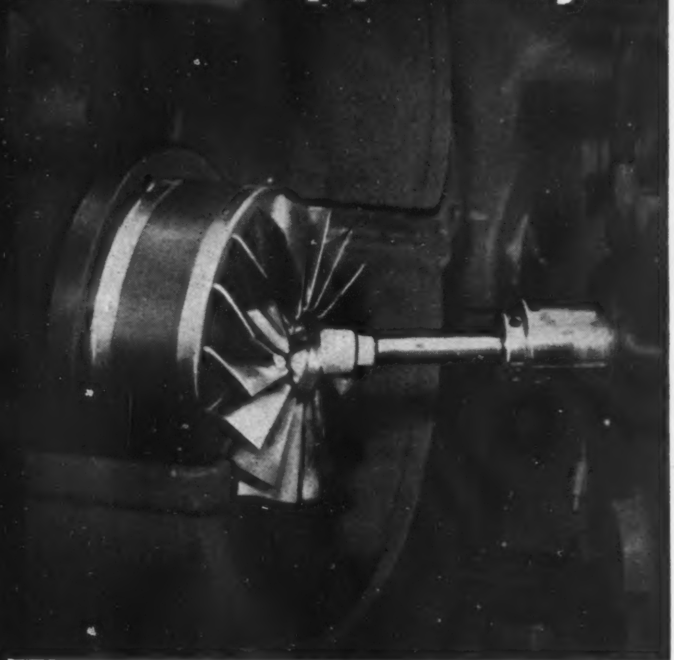

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PM 123

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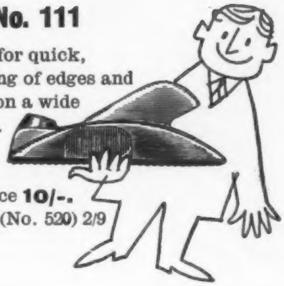

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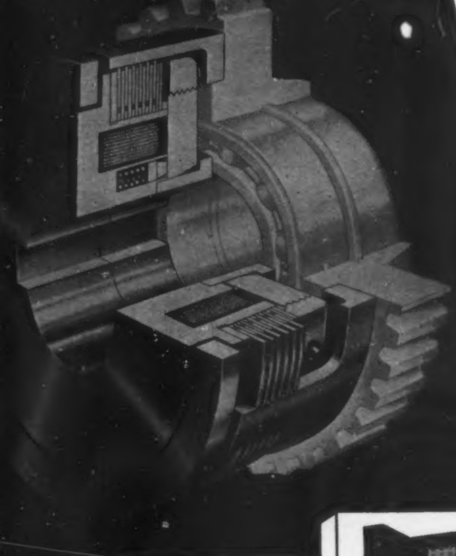

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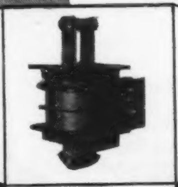

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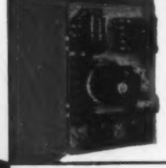

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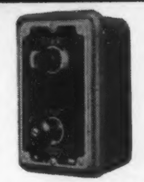

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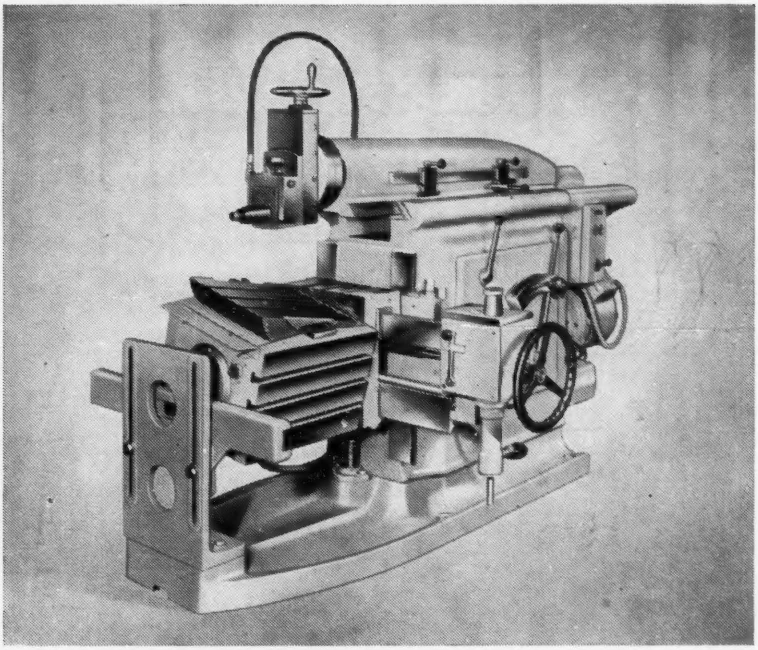

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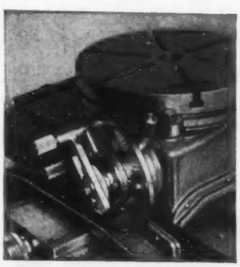
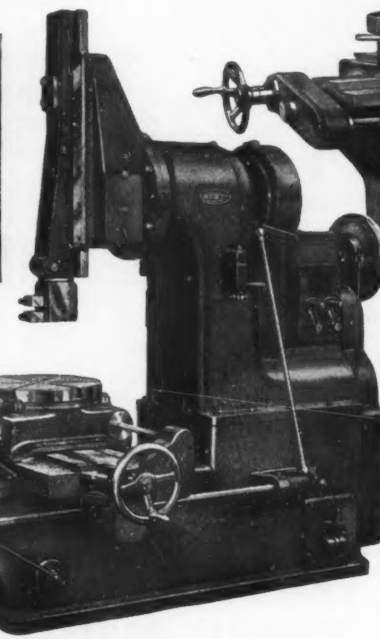


Close-up showing dividing attachment on rotary table



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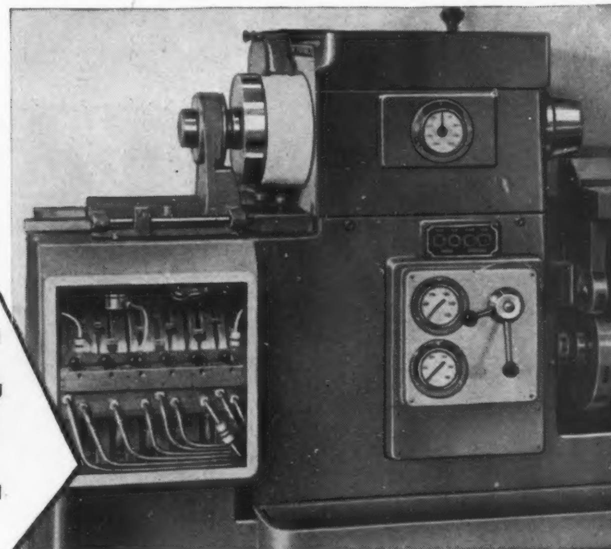

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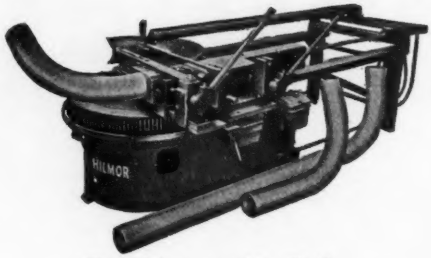

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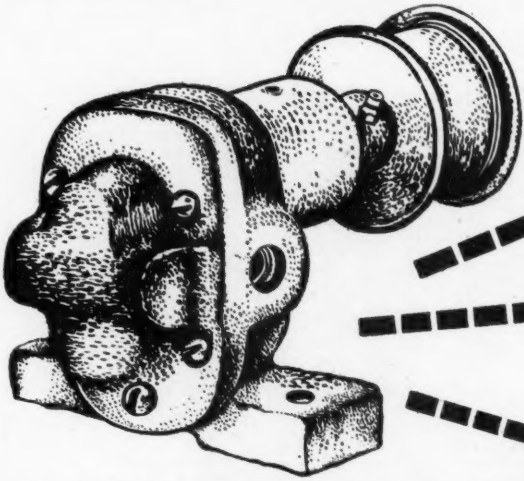

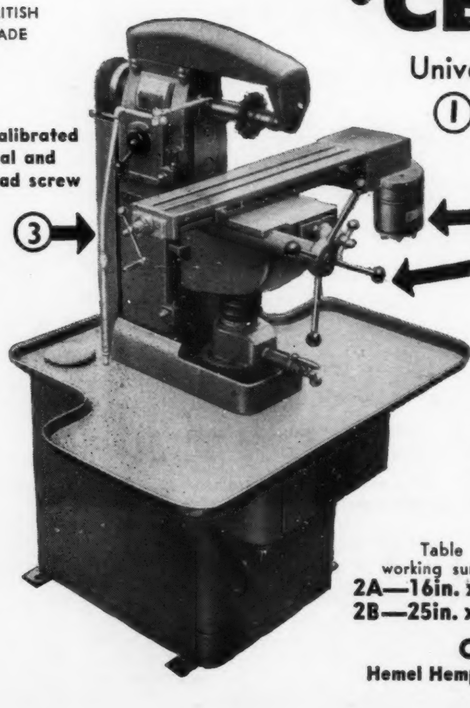

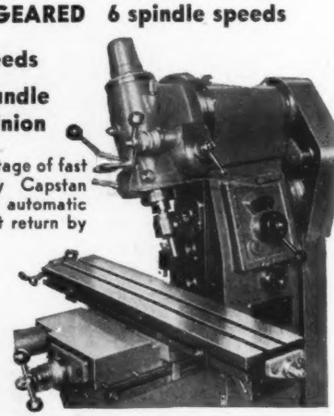

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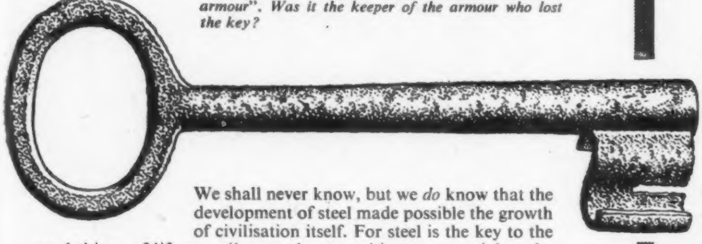

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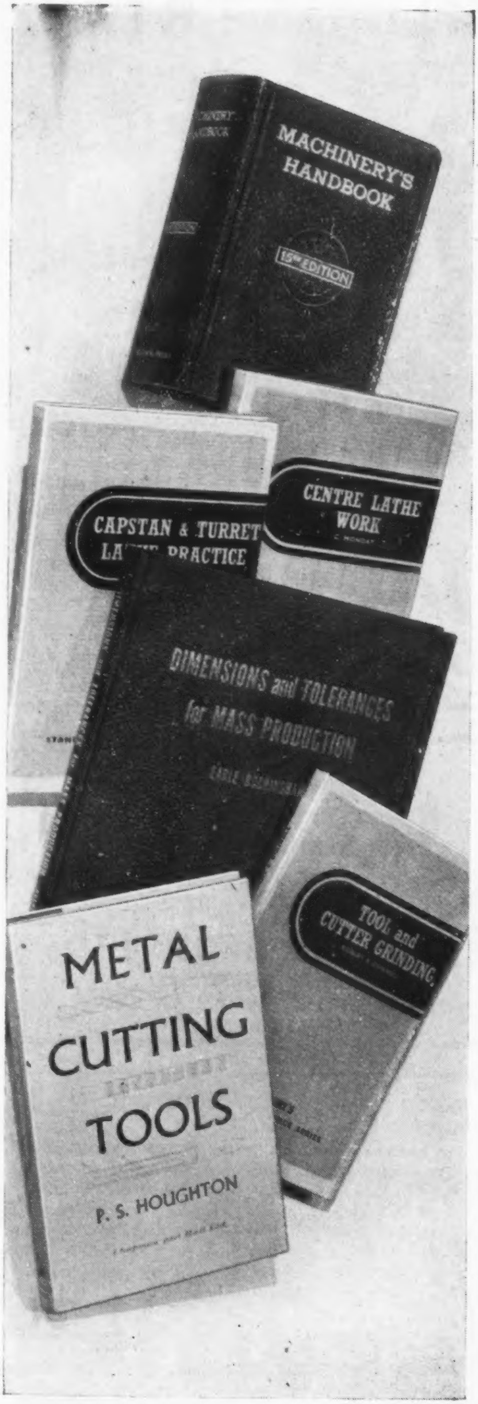

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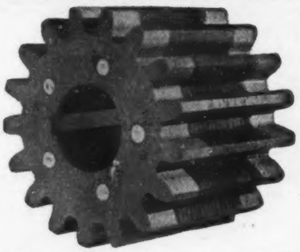

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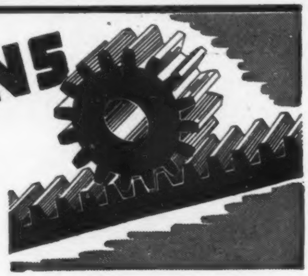

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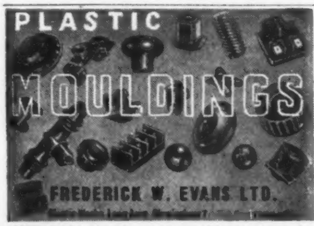

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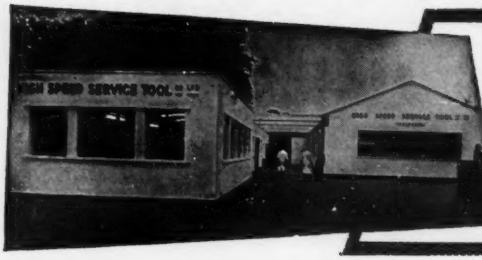

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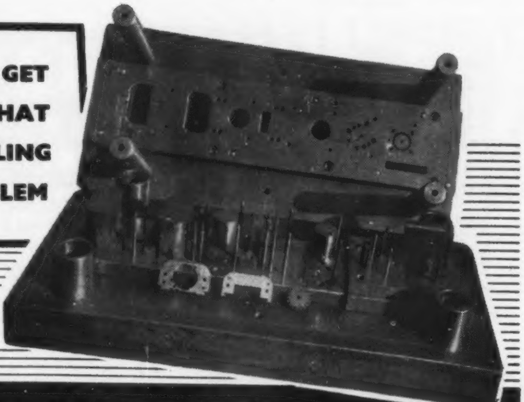

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New Richmond SR2 36in. Radial Drill, motorised 400/3/50. IN STOCK for your inspection.—JAMES W. CARR & CO., LTD., 7-15, Rosebery Avenue, E.C.1. 'Phone: TERminus 8866 (P.B.E.).

Snow P24 Hydraulic Horizontal Surface Grinding Machine, capacity 24in. by 8in., motorised 400/3/50. Two machines available.—SOUTHERN ENGINEERING & MACHINERY CO., Connaught Buildings, Tanners Brook, Millbrook, Southampton. Tel.: Southampton 73101.

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LANG 16in. × 20ft. Lathe, twin saddles.
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CINCINNATI No. 2 Dial Type Vertical and Horizontal Millers.
CHURCHILL 14in. × 36in. Plain Cyl. Grinder.
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6ft. 0in. × ¼in. Bending Rolls (New).
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10½in. MITCHELL S.S. & S.C. Lathe, 5ft. b.c.
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24in. DEAN, SMITH & GRACE Boring and Facing Lathe.
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1S, 2S, 2D, 2B, 4B HERBERTS. TO CLEAR CHEAP.
PLATE Drilling Machine, 2 spindle, No. 5 M.T.
24in. BULLARD Vertical Borer.
⅞in. B.S.A. Auto. Long Stroke. Slotting attachment.

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Heavy Duty Hydraulic
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Classified Advertisements (*PLANT FOR SALE, contd.*)

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C·E·M

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BENTLEY Plate Bending Rolls, 6ft. by ¼in., 8ft. by ⅜in. and 8ft. by ½in. New.
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SEDGWICK Universal Plate Bending and Folding Machine, 6ft. by ¼in. capacity.
BENTLEY 200-ton Power Press, 8in. stroke. New.
BENTLEY 80-ton Power Press, adj. stroke. New.
BENTLEY 50-ton Power Press, adj. stroke. New.
CINCINNATI No. 2 Dial Type Horiz. Mill.
WICKMAN 5in. five-spindle Automatic.
PROGRESS 4E Drilling Machine, suds, New.

All machines motorised 400/3/50.
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Herbert Hacksaw, 13in. blade, belt driven.

Wicksteed Hydrofeed Hacksaw, 16in. blade, 6in. by 6in.

Rex Hydraulic Hacksaw, 18in. blade, 8in. by 8in.

Colchester 7in. Centre Lathe, 7ft. gap bed, A.G.H.

Herbert Horizontal Milling Machine, 3ND, table 61in. by 15in., 4 spindle speeds.

3,000 K.G. Capacity Avery Hardness Testing Machines, 10in. dia. table (2).

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Crow Harvey Punch, Shears and Angle Cropper, 18in. blade, 27in. throat, heavy duty.

Pels Punch, Shears and Cropper, 12in. blade, shear ¾in., takes 6in. by 6in. by ⅝in. angles.

Craig & Donald Billet Shears, 8in. blade, 6in. by 1in. capacity.

Robertson Shears, ¾in. capacity, 10 h.p., 28in. blade, 9in. maximum opening. (2)

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Massey 3-cwt. Bottle Forging Hammer.

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K·E·N·T

Monarch 14AA 8in. S.S. & S.C. Lathe. £625.
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Herbert O Capstan, £110.
Butterworth 1⅝in. Automatic. £475.
Haskins 5/16in. Capacity Tapping Machine. £60.
Corona 2AX No. 2 M.T. Drilling Machine. £67 10s. 0d.
Zimmerman Hori. Boring Machine, 2in. travelling spindle. £325.
Parkson Horizontal Milling Machine. Table 51in. by 11in. overall. £195.
Speedax No. 2 Riveter. £35.
Jos. Heap 1in. Tangential Screwing Machine. £165.
Ward OE Capstan. Bar feed. £165.
Hardinge Precision Lathe, 5in. £37 10s.
Peterman P.10 S.S. Auto. Extensive collets and equipment. £395.
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All machines mot. 400-440/3/50.

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HERBERT 23V Vertical Miller, table 68in. by 12in., auto longtl. feed 48in., auto cross feed 18in., vertical travel 25in., vertical adjustment of head 10in., spindle speeds 16·5 to 427 r.p.m.

LEES-BRADNER Type HT Thread Milling Machines, capacity 12in. dia. by 102in. long.

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HERBERT 2D Capstan, B.C. and B.F.
WARD 10 Combination Turret Lathe.
HERBERT No. 8 Combination Turret Lathe, covered bed.
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HERBERT 5A Capstan chucking m/c.
HERBERT No. 4 Capstans, 4 chucking machines.
ACME 5W Turret Lathe, chuck machine.
HERBERT Model O Capstan, pneumatic bar chuck and bar feed.
WARD 3A Capstans. B/C and B/F. 2 M/cs.
WARD 2A Capstans, B/C and B/F.
D.S.G. 13Z MINOR 6½in. by 31in. S.S. & S.C. Lathe.

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ARCHDALE Mod. 2220 Pillar. 1¼in. cap., p/feeds.
HERBERT Type "C" Pillar, 1¼in. cap., p/feeds.
JONES & SHIPMAN Fig. 921, 30in. Pillar, 2in. cap., p/feeds.

GRINDERS.

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CHURCHILL Mod. H.A.Y. Internal Hyd.
NEWALL 10in. by 36in. Plain Hyd.
ABRASIVE Mod. 3B Surface, cap. 8in. by 24in.
CHURCHILL Mod. N.B. Horizontal Surface, cap. 6in. by 18in.
SNOW Mod. OS72 Hor. Spindle Surface, hyd. cap. 72in. by 18in.
PALLAS No. 0 Surface, cap. 14in. by 5¾in.
NEWALL Mod. L.U. 12in. by 36in. Hyd. Universal.
B.S.A. LANDIS Type "C" 6in. by 18in. Hyd. Plain.
CHURCHILL Mod. B.Y. Hyd. Angle Head Automatic, plain.
ABWOOD Vert. Spindle, Surface, cap. 18in. by 6in. (AS NEW.)
CHURCHILL Mod. H.C.B. Hyd. Auto Sizing. Internal.

MILLERS.

MILWAUKEE Mod. 2HL. Plain.
KENT-OWEN No. 1/14 Hyd. Plain. 2 m/cs.
VAN NORMAN No. 2L Plain, table 45in. by 10in.
CINCINNATI Mod 08 Vert., table 24in. by 6in.
HERBERT No. 1 Plain, with auto. feed.
ARCHDALE 20in. Plain, with rapid traverse.
CINCINNATI 18in. Manfg. Model O.K., table 34in. by 12in.
ARCHDALE 14in. Plain, table 27in. by 8in., long. travel 14in.
ASQUITH Type V Vert., table 50in. by 14in., long. travel 28in.

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CLEVELAND Rigidhobbers, 2 machines, mod. 120, 1 machine mod. 130.

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TOWN 3ft. No. 2 M.T. Radial Drill. Speed range 126-1,450 r.p.m.
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KEARNS Type OA Horizontal Boring Machine.
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MUIR 17in. Stroke Vertical Slotting Machine.

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LANDIS Plain Hydraulic Cylindrical Grinding Machine, capacity 10in. by 96in.
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LANDIS Type D Hydraulic Crank Pin Grinding Machine, capacity 21in. by 72in.
NEW **EXCEL** No. 3 Hydraulic Surface Grinding Machine.
NEW **EXCEL** No. 5 Tool and Cutter Grinder.
BROWN & SHARPE No. 2 Surface Grinding Machine, capacity 6in. by 18in.
NORTON Universal Grinding Machine, type "C", capacity 12in. by 36in.
LANDIS Type "C" Plain Hydraulic Cylindrical Grinding Machine, capacity 10in. by 36in.
CHURCHILL Universal Grinding Machine, 10in. by 24in. between centres.
NORTON 6in. by 18in. Plain Cylindrical Grinding Machine.
B.S.A.-LANDIS Type "C" Plain Hydraulic Cylindrical Grinding Machines, 6in. by 30in. (Two available.)
CHURCHILL Model HBY Internal Grinding Machine.

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UNION Horizontal Boring Machine, Model BFT. 100 3$\frac{15}{16}$in. dia. travelling spindle, 24in. dia. facing head (1957).
RICHARDS Type PRT Horizontal Type Floor Boring Machine, 3½in. dia. travelling spindle and 28in. dia. facing head.
ASQUITH 7in. Horizontal Floor Boring Machine.
BERTHIEZ Model 9340 Vertical Boring Mill table diameter 7ft. 10in., maximum turning capacity 9ft. 6in. (1953.)
JUNGENTHAL Model KE.1200 Vertical Boring Mill, table diameter 39in., maximum, turning capacity 50in. (1954.)
FRORIEP Vertical Boring Mill, table diameter 39in., maximum turning capacity 52in. (1955.)
KEARNS No. 3 Horizontal Boring Machine, 3½in. diameter travelling spindle, maximum facing diameter 24in.
RICHARDS Double Column 6ft. Vertical Boring Mill, maximum turning capacity 72in.

MILLING MACHINES

MILWAUKEE No. 2H Vertical Milling Machine, table 50in. by 10in.
REED PRENTICE No. 6 Vertical Milling Machine, table 84in. by 20in.
SUNDSTRAND Hydro-Screw Rigidmill Automatic Production Milling Machine, table 7in. by 14in., table traverse 48in.
CINCINNATI 1/12 Horizontal Production Milling Machine.
CENTEC Model 3R Automatic Production Milling Machine, table 8in. by 30in.
CINCINNATI 2M Universal Milling Machine.
MILWAUKEE No. 4H Plain Horizontal Milling Machine, table 74in. by 15½in.
CINCINNATI No. 3 Dial Type Plain Horizontal Milling Machine, table 62½in. by 15in.
VICTOMATIC Automatic Cycle Production Milling Machine, capacity 50in. by 10in.
REED-PRENTICE No. 5 Vertical Milling Machine, table 68in. by 16in.

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DRILLING MACHINES

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ARCHDALE Multi-spindle Drill Machine, 36 spindles.
HETTNER Radial Drilling Machine, having 10ft. Radial Arm elevating column type.
TOWN 30in. Vertical Spindle Boring, Drilling and Tapping Machine, No. 5 M.T..
KITCHEN & WADE 4ft. 6in. Radial Drilling Machine.
KITCHEN & WADE 4ft. Radial Drilling Machine.
ASQUITH ODI 6ft. Radial Drilling Machine.

CAPSTAN & CENTRE LATHES

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BRADFORD 8½in. centre height by 30in. between centres Centre Lathe.
HERBERT No. 8 Combination Turret Lathe.
URQUHART LINDSAY & ROBERTSON ORCHAR Centre Lathe, 16in. by 30ft. 6in. between centres.
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HERBERT No. 12 Combination Turret Lathe with comprehensive tooling.
NILES Centre Lathes 13½in. centre height by 27ft. between centres. (Two available.)
NILES Centre Lathes, 15in. centre height by 28ft. between centres. (Two available.)
BETTS-BRIDGEFORD Centre Lathe, 15in. centre height by 16ft. between centres. (Two available.)
WARD No. 7 Combination Turret Lathe.

AUTOMATICS

ACME GRIDLEY Model RA6 2$\frac{5}{8}$in. spindle Bar Automatic.
PONGRACZ Single Spindle Automatic capacity 10 mm.
CONOMATICS 3½in. 4-spindle Bar Automatics. (Three available.)

PLANING MACHINE

URQUHART LINDSAY & ROBERTSON ORCHAR Spiral Drive Heavy Duty Planing Machine, capacity 16ft. by 5ft. by 5ft.

Newman *for* MACHINE TOOLS

Topical Touch

Fashion note at Trooping the Colour*

* Newman—a cymbal of sound value

All the machines on this page are motorised for 400-440 volts, 3-phase, 50 cycles.
For further details of any item listed or for a copy of our complete Stocklist write or 'phone

NEWMAN INDUSTRIES LIMITED

Machine Tool Division — **YATE, BRISTOL**
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UNREPEATABLE BARGAIN for GOOD CLASS USED MACHINE TOOLS

9in. **LANG** Toolroom S.S. & S.C. Lathe, 4ft. 0in. bet. centres, speeds 12-600 r.p.m. Serial No. 27649/1587. Full equipment £375

6in. × 30in. **PRATT & WHITNEY** Toolroom Lathe, full equipment including T.T. att. £225

CINCINNATI 1/18 Automatic Cycle Milling Machine. Table 41in. × 10in. Speeds 50-1,500 r.p.m. £325

CINCINNATI 1/12 Automatic Cycle Milling Machine, speeds 50-1,500 r.p.m. £300

BLANCHARD No. 10 Vertical Rotary Surface Grinder. 16in. dia. Table. 10in. Wheel. £250

2-Off **GISHOLT** No. 4 Universal Turret Lathes. Speeds variable to 730 r.p.m. Hardened Bedways. Power feeds to cross slide and turret, complete with full equipment. War time machines. Each £200

2-Off **LIBBY** 4R Universal Turret Lathes. Swing over Bed 20in. Power feeds to cross slide and turret. Speeds to 725 r.p.m. Chucking machines with full equipment. Each £185

1-Off **LIBBY** 4R Turret Lathe, as above, but Ball Chuck Bar Feed. £225

WICKMAN Profile Grinder, 50-1 Pantograph, 50-1 Microscope. £650

LANDIS 6in. × 18in. Hydraulic Plain Cyl. Grinder (American built) in perfect condition. £450

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ORMEROD 12in., unused; table dia. 30in., admits in dia. 50in., h.p. motor 8.

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BUTLER 8in. High Production, table dia. 20in., admits in dia. 24in., h.p. motor 5.

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All with automatic and hand, long./cross and rotary table movements.

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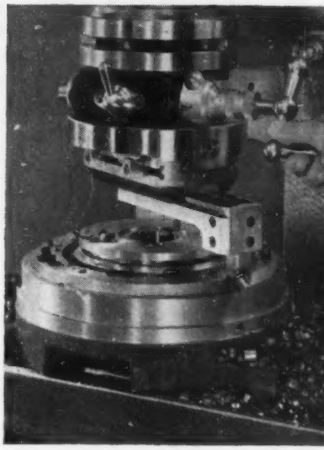

Capacities: 6in., 10in. and 14in. diameter facing

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UNIVERSAL BORING FACING & TURNING ATTACHMENT

Direct reading to 0·0005in., hand and two rates auto feed, automatic stop, all for operation whilst rotating.

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Kent-Owen Production Miller. Auto. cycle. Table 32in. × 9in. o/a. Kneeless type. Motorised.—WILCOX & CO., Barr Street, Birmingham 19. Northern 1234/5.

R. E. Ormerod Ltd., Bromsgrove 3411—offer one Archdale 18in. Vertical Milling Machine, 2,000 r.p.m., at £625, or will go to the best offer made within the next three weeks. Seen working, any trial.

One Motorised Single Spindle Herbert Drilling Machine.

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All nearly new, with double spindle hand grinder and two new 4in. vices.

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RICHARDS 48in. Double Upright Vertical Boring and Turning Mill, two swivelling toolboxes on cross slide.

CAPSTAN & TURRET LATHES

WARD 2A Bar Capstan Lathe, fitted collet chuck, speeds 71 to 1,541 r.p.m. War-time manufacture.
HERBERT 4BS Bar Capstan Lathe, fitted turret toolholders, pump, bar feed, speeds 30 to 511 r.p.m.
WARD No 7 Bar Capstan Lathe, bar feed, speeds 20 to 416 r.p.m.
HERBERT No. 20 Combination Turret Lathe, 7½in. diameter spindle, 28in. swing over bed, 97in. distance spindle to turret. Speeds 5 to 201 r.p.m.

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LE BLOND Heavy Duty 33in. swing by 28ft. between centres, S.S. & S.C. Lathe, late type, all geared headstock, twin saddles, taper turning, 32in. diameter, four-jaw chuck, 25 h.p. A.C., 3-phase electrics, speeds 4 to 255 r.p.m.
BROADBENT 14in. S.S. & S.C. Gap Bed Lathe, admits 90in. swings in gap 50in., speeds 5·5 to 204 r.p.m. Well equipped Nearly New.
BINNS & BERRY 12½in. S.S. & S.C. Gap Bed Lathe, admits 7ft. 6in. between centres, speeds J2 to 600 r.p.m. NEW.
COLCHESTER MASCOT 8½in by 54in. All-geared Head Centre Lathe, speeds 37 to 600 r.p.m. NEW.
COLCHESTER TRIUMPH 7½in. by 48in. All-geared Head Gap Bed Lathe, speeds 40 to 800 r.p.m. NEW.
DEAN SMITH & GRACE Model "AN" 7½in. by 48in. S.S. & S.C. Straight Bed Lathe, speeds 11 to 490 r.p.m. Serial No. 20300.
WILLSON Mark V 7½in. by 48in., S.S. & S.C. Gap Bed Lathe, admits 48in., speeds 54 to 954 r.p.m. and 37 to 739 r.p.m. NEW.
DEAN SMITH & GRACE Type "A" 7in. by 31in. S.S. & S.C. Gap Bed Centre Lathe, speeds 11 to 490 r.p.m. Serial No. 21303.
REIDEN 7½in. by 40in. S.S. & S.C. Gap Bed Toolroom Lathe, fitted taper turning attachment, pump, 3-jaw chuck, speeds 25 to 1,350 r.p.m. NEW.
MITCHELL 6½in. by 64in. S.S. & S.C. Gap Bed Centre Lathe, taper turning attachment, speeds 27 to 400 r.p.m. Nearly New.
MYFORD Super Seven Lathe, 3½in. by 19in., speeds 25 to 2,150 r.p.m. NEW.

DRILLING MACHINES

RICHMOND S.R.2 36in. Radial Drill, elevating table, suds pump. NEW.
JONES & SHIPMAN 30in. Model 921, 2-spindle Manufacturing Drilling Machine. 1¼in. capacity, speeds 39 to 825 r.p.m. Table 42in. by 24in.
PROGRESS 3A Pillar Drilling Machine, Circular table. NEW.

***THIS WEEK'S* SPECIAL**

Machine Tool Values Competition;
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JONES & SHIPMAN 18in. by 6in. capacity Hydraulic Horizontal Spindle Surface Grinder, Model 540. Nearly New.
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LANDIS Hydraulic Universal Grinder, type "C", capacity 10in. by 24in. Serial No. 27916.
MYFORD M.G.12 Plain Cylindrical Grinder, capacity 5in. by 12in. NEW.

MILLING MACHINES Vertical

CINCINNATI No. 4 Dial Type Vertical Milling Machine, table 78½in. by 16½in. rapid and power traverses 42in. by 16in. by 16in. Speeds 18 to 1,300 r.p.m. British built 1941.
BIERNATSKI No. 5 Swivel Head Vertical Milling Machine, table 78in. by 19in., traverses 49in. by 15in. by 35in.
CRAVEN Swivel Head Vertical Milling Machine, table 47in. by 13in., traverses 42in. by 7in. by 12in., speeds 41 to 1,188 r.p.m.

Universal

CINCINNATI No. 4 Dial type Universal Milling Machine, table 78½in. by 16½in., rapid and power traverses, 42in. by 14in. by 19in. Speeds 18 to 1,300 r.p.m. With Universal Vertical Attachment. British built 1947.
REIDEN H.F.30 Universal Milling Machine table 59in. by 14⅜in., rapid and power traverses 39⅜in. by 11¾in. by 15¾in., speeds 44 to 1,457 r.p.m. NEW.
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RICHMOND No. 3 Universal Milling Machine, table 48in. by 11in., rapid and power traverses 30in. by 8in. by 16in., speeds 20 to 1,000 r.p.m. NEW.
DENBIGH C.4 Universal Milling Machine, table 46in. by 10in., automatic longitudinal feed 36½in., speeds 13 to 400 r.p.m. NEW.

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Classified Advertisements (*PLANT FOR SALE, contd.*)

MODERN

NEW MACHINES

MITCHELL 12½in. Lathe, 10ft. 9in. between centres, 4½in. hollow spindle. Equipment.

MYFORD MG12 Cylindrical Grinder, 3 × 12 capacity. Full equipment.

MIDGLEY & SUTCLIFFE O3SD Universal Miller. Universal Dividing Heads.

COLCHESTER 'Mascot' 8½in. × 54in. Lathe. With equipment.

GRANOR Type HL 11in. Gap Bed Lathe. 5ft. between centres. Full equipment.

COLCHESTER 'Triumph' 7½in. × 48in. Lathe, Coolant, fourway toolpost, etc.

MITCHELL 8½in. Gap Bed Lathe, 4ft. 3in. between centres, fourway toolpost, chucks, etc.

VICTORIA U3 Universal Miller, 60in. × 12½in. table, rapid traverse.

MODERN 2C 1½in. capacity Capstan. Complete with bar feed.

SMART AND BROWN Model 'A' 4½in. S.S. & S.C. Precision Toolroom Lathe.

HARRISON 8in. × 48in. Lathe. Fourway toolpost, chucks, steadies, etc.

MODERN 18in. × 6in. Fully Automatic surface Grinder, 12in. wheel to table.

USED MACHINES

VAN NORMAN Vertical Miller, 56 × 10½in. table, Power and rapid traverse all directions. Very good condition. **Price £1,150.**

WILSON Newel 7½in. Lathe. Fourway Toolpost chuck, etc. Late machine, excellent condition. **Price £345.**

WARD No. 7 Capstan. Fully equipped. Levers and nuts Arranged as chucking machine. Good order. **Price £550.**

REINECKER FV1 Vertical Miller, 43in. × 10in. table. 20in. between spindle and table, dial change, as new condition. **Price £1 050.**

LUND Precimax MPL 6 × 36 Grinder, 20 × 4 wheel. Coolant equipment, etc. **Price £525.**

HERBERT Small piece Lathe. Type 6WSL 12in. swing two tailstocks. **Price £110.**

ADCOCK & SHIPLEY 3ft. Radial Drill. Power feed to spindle. Coolant equipment. Good condition. **Price £325.**

HERBERT 2B Cqpstan. Collet attachment, chuck bar feed, tooling, etc. **Price £300.**

DELAPENA Model MA Bench Honer, 0·185 to 2·625 capacity. **Price £50.**

MITCHELL 14½in. Lathe. 7ft. 9in. between centres. 4½in. hollow spindle. Equipment. Overhauled. **Price £1,950.**

MODERN MACHINE TOOLS LTD.

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SOAG

STIRK "PIONEER," 8ft. × 3ft. 6in. × 3ft. double column Planing Machine. All electric split-field drive with two tool heads on cross rail; tool lifts; cutting speeds up to 240 r.p.m. Modern machine, unused.

CHURCHILL-REDMAN 14ft. × 3ft. 6in. × 3ft. 6in. double column, Lancashire Dynamo drive, two tool heads on cross rail and two side heads, push button and control panel. In sound working order and condition.

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'Grams: Sotoolsag, London, S.E.11.

Centreless Grinding Machine, B.S.A. Max. capacity 3in. dia. Electrics 400/3/50. Excellent condition.—BOX V985, MACHINERY, Clifton House, Euston Road, N.W.1.

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Hasse & Wrede Heavy Duty carbide tool comb. turret lathe. 1952 manufacture. 19¾in. swing. 59in. between spindle and turret face. 18 speeds preselected 18/900 r.p.m. 9 feeds. 3½in. dia. through spindle or 2¾in. dia. with hydraulic chucking. Turret accepts Herbert tooling 400-440 electrics. Can be seen working. £1,200 or near.—ROBERTSONS (ENGINEERS), LTD., New Street, Horsforth, Leeds.

Radyne 6-kW Induction Heater with pump and accessories, £850.—HARDEN PRECISION ENGINEERING CO., LTD., Manor Estate, Church Road, Thundersley, Essex.

Blanchard No. 10 Rotary Table Surface Grinder. 16in. dia. mag. table. 10in. dia. cup wheel. Motorised.—WILCOX & CO., Barr Street, Birmingham 19. Northern 1234/5.

Facing Lathe "VDF" Face Plate, diam. 5ft., swing 6ft. diam. over bed, admit 20ft. between centres. Motorised. (1942) good condition.—Further details from DR.-ING. EMIL LINGEMANN, Rather Str. 49, Dusseldorf, Germany.

Brown & Sharpe 00 and 0 H.S. Automatics, ex. cond., also No. 0 and 2 Reg. B.S.A. ⅜in. long stroke, third slide, Brown and Ward ⅜in. 4-Op. Threader, Mot.—C. L. THOMAS, LTD., 18 Park Avenue, Solihull 1281.

Sweeney & Blocksidge 25-ton column press, adj. stroke, Mot. current model in first class condition. Half list price, also Bliss inclinable 15 ton, Mot. £95.—C. L. THOMAS, LTD., 18 Park Avenue, Solihull 1281.

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1 Die Casting Machine EMB. No. 9, cold chamber, in excellent condition. —inspection invited.—Offers: BOX Z3, MACHINERY, Clifton House, Euston Road, N.W.1.

Ward 3A Capstan Lathe, Serial 86100, fitted with 7½in. 3-jaw airchuck and control gear, power feeds to turret, speeds 59 to 1,155, electric coolant pump, self-contained machine, 400-440/3/50, very good condition. £350.—E. SMITH (MACHINE TOOLS), LTD., 76, St. Lukes Road, Birmingham, 5. Tel.: CALthorpe 3761.

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4 mm. Wickman Automatic Machine Vinco A.C.W. 5 slides. Slotting, Drilling and Threading attachment. 50/3/400. Speeds 1,500-12,000. Very good condition. £245.—BOX V987, MACHINERY, Clifton House, Euston Road, N.W.1.

Classified Advertisements (*PLANT FOR SALE, contd.*)

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Unused **RUSHWORTH** 6ft. by ½in. M.S. Overcrank Double Geared Drive Guillotine Shearing with cam operated plate hold down, 6in. gap in end frames.

New **PEARSON** 10ft. by ⅜in. Electro Hydraulic Guillotine Shearing Machine with 12in. gap in end frames.

New **PEARSON** 8ft. by ¾in. Electro Hydraulic Guillotine Shearing Machine with 12in. gap in end frames.

Unused **RUSHWORTH** 150/8 All Steel Frame Press Brake, forming capacity 8ft. by ¼in. M.S. Distance between columns 97in. Overall bed 114in. Die space ram down 12in. Gap in end frames 10in.

Unused **RUSHWORTH** 75/8 All Steel Frame Press Brake, forming capacity 8ft. by ⅛in. M.S. Distance between columns 97in. Overall bed 108in. Die space ram down 12in. Gap in end frames 9in.

Unused **PELS MB.22** All Steel Combined Punching, Shearing and Section Cropping Machine, capacity in mild steel, shear ⅞in., punch 1¼in. through ⅞in. Crop 6in. by 6in. by ⅝in., angles at 90° or 4in. by 4in. by ½in. at 45°, 2⅜in. rounds, 2in. squares.

New **WEYBRIDGE MS.48** Medium Type Rotary Gang Slitting Shear. Max. capacity 6-cuts in 48in. by ⅛in. mild steel.

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New **STECO** 8ft. by ¼in. Pyramid Type Plate Bending Rolls, 8¼in. dia. Top Roll, 7¼in. dia. Bottom Rolls.

Three-Used **RHODES** 7½/72 Straight Side Double Crank Geared Power Presses, capacity 200-tons. Bed area 72in. by 50in. Stroke 12in. Complete with 'Worson' Air Cushion equipment.

Used **TAYLOR & CHALLEN** 7½ Double Action Geared Toggle Drawing Press, Punch stroke 20in. Blankholder stroke 10in., 44in. between uprights.

All arranged for Motor Drive 400-440/3/50.

GEORGE COHEN SONS & COMPANY LIMITED
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Tel: Elgar 7222/7

Universal Grinding Machine, with Internal and External Wheel Spindle. Hydraulic feed to table. Precimax model UPH, 10in. by 24in. Electrics 400/3/50. In excellent condition.—BOX Z35, MACHINERY, Clifton House, Euston Road, N.W.1.

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can recommend the following modern quality machines from STOCK:

KEARNS No. 2 HORIZONTAL BORING, MILLING, DRILLING AND FACING MACHINE, 3in. sliding spindle, 20in. dia. facing head. Size of top table 48in. by 48in.
SWIFT 4ft. RADIAL DRILLING MACHINE. Elevating arm, box table.
BROWN & SHARPE HORIZONTAL SPINDLE SURFACE GRINDING MACHINE. Capacity 18in. by 6in.
HERBERT No. 4 AUTOMATIC CHUCKING LATHE.
PARKINSON No. 3J UNIVERSAL MILLING MACHINE.
PRATT & WHITNEY 12in. STROKE SLOTTING MACHINE. Tilting ram.
MODERN OPTICAL PROFILE GRINDING MACHINE.
LANG JUNIOR CENTRE LATHE. Capacity 6½in. centre height by 30in. between centres.
CHURCHILL-REDMAN HEAVY DUTY SHAPING MACHINE. 24in. stroke, swivelling vice, 10 h.p. motor.
BUTLER 8in. STROKE SLOTTING MACHINE, with tilting table.
B.S.A. 9in. SINGLE SPINDLE CHUCKING AUTOMATIC. Complete with air-operated chuck.
KITCHEN & WADE VERTICAL FINE BORING MACHINE. 14in. stroke. Compound table.
KITCHEN & WADE HEAVY DUTY PILLAR DRILL. No. 5 Morse. Speeds 22-1,000 r.p.m.
CHURCHILL 12in. by 36in. UNIVERSAL HYDRAULIC GRINDING MACHINE.

Further details from

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BRANDON ROAD WORKS, BRANDON ROAD, COVENTRY.
'Phone: WALSGRAVE-ON-SOWE 2213/4

Kendrick Press Brake, 6ft. by 18g. capacity in steel, motorised 400/3/50—SOUTHERN ENGINEERING & MACHINERY CO., Connaught Buildings, Tanners Brook, Millbrook, Southampton. Tel.: Southampton 73101.

Scrivener No. 2 Centreless Grinder Reconditioned, with Hydraulic Wheel Trimmer. Motorised 400/3/50.

THE SURPLUS MACHINERY & STORES CLEARING HOUSE LTD.
108 East Hill, Wandsworth, London, S.W.18
Phone: Vandyke 3266-7-8

E. H. Jones No. 55 (New) Vertical Milling Machine, table 32in. by 11in., motorised 400/3/50.—SOUTHERN ENGINEERING & MACHINERY CO., Connaught Buildings, Tanners Brook, Millbrook, Southampton. Tel.: Southampton 73101.

EX STOCK

New MODERN 2C Capstans, 1⅛in. bar feed.
Used WARD 1A Capstan, 1in. bar feed.
New CHIPMASTER 5 × 20 High Speed Precision Lathes.
New STUDENT 6 × 24 Lathes.
New WILLSON 7½in. Mark V Lathe.
New PROGRESS 4E Pillar Drill, 1¼in.
New Q. & S. Pillar Drill, 1½in.
New Q. & S. (Kerry) Radial Drill, 3ft. × 1½in.
New RICHMOND Radial Drill, 4ft. × 2in.
Selection of Bench and Pillar Drills, ½in. to 1½in.
New SMART & BROWN Precision Lathes, Models M.L. and SABEL.
New SENIOR Horizontal Millers, M1.
New DENBIGH Horizontal Millers, C4. Latest variable feed.
New E.H.J.55 Vertical Miller.

C. H. JOYCE LTD
32-40, Monkton St. (Kennington), London, S.E.11.
RELiance 1437-9.

Many other machines of various types available also, please ask for Stock list.

NORTON 12in. by 36in. Universal Grinder, hydraulic, motorised 415/3/50. With internal grinding attachment, and other useful equipment.
HERBERT HUNT Horizontal Surface Grinder, 6in. by 18in., with wheel truing device and dust extraction unit, 415/3/50.
LUKE & SPENCER type Double Ended Grinder, wheels 16in. dia. by 2in. wide. 415/3/50.
FIRTH-BROWN Twist Drill Grinder, capacity up to ½in., with quantity of drill bushes. 415/3/50.
KEARNS No. 0 Production type Horizontal Borer with 2in. dia. traversing spindle. Top table 30in. by 36in.
BULLARD 38in. Vertical Boring and Turning Mill. Twin columns. Pentagon turret and one plain swivel toolpost. S.P. drive.
HERBERT No. 9S Combination Turret Lathe. 415/3/50. 4⅛in. hollow spindle. Good equipment.
WARD No. 8 Combination Turret Lathe. 415/3/50. 4¼in. hollow spindle, taper turning attachment.
PITTLER H.R.A. Turret Lathe, arranged for bar feed and chucking. Bar capacity 4 1/64in. 415/3/50.
WARD No. 2A and 3A Capstan Lathes with bar feed and automatic ball chucks, power feed to turret and saddle. 415/3/50.
CLIFTON & WADDELL 36in. Heavy Duty Metal Bandsawing Machine with two movable tables 21in. by 40in. 415/3/50.
RAPIDOR 20in. Power Hacksawing Machine.
RAPIDOR 10in. Power Hacksawing Machine. 415/3/50.
RAPIDOR 8in. Power Hacksawing Machine. 415/3/50.
Etc., Etc.

46, Minerva Road, Park Royal, LONDON, N.W.10.
Telephone: ELGar 4841/2.

Classified Advertisements (*PLANT FOR SALE, contd.*)

MIDLAND

ACME GRIDLEY 1in. cap. six spindle bar auto. Bar feed, collets, tooling and live spindle.

BROWN & SHARPE 2G Auto. 1in. cap. Bar feed and tooling.

HERBERT Junior Chucking Auto. 6in. swing. Very well equipped.

FISCHER K.D.M. 11/70 Copying Lathe. Automatic. 1954 machine.

LANG 15in. by 15ft. S.S. & S.C. Lathe.

BROWN & SHARPE No. 2 Universal Grinder. 14½in. swing by 28in. b.c. Well equipped. First class condition.

PILKINGTON 5-cwt. Air-operated Power Hammer. Almost new.

HARRISON 7½in. by 4ft. S.S. & S.C. Gap Bed Lathe. Full equipt. and taper turning. As new. 1956 machine.

MILWAUKEE 2 C.E. Horizontal Miller. Vertical and slotting heads. Speeds to 2,000 r.p.m. As new. 1954 machine.

1952 **BIERNATZKI** Heavy Duty Horizontal Miller. Speeds 29 to 1,500 r.p.m. Quick Power all ways. As new condition.

HERBERT No. 7 Combination Turret Lathe. Screwcutting. 2⅞in. hollow spindle.

HERBERT 21 Combination Turret Lathe. 34in. swing. 7½in. hollow spindle. Screwcutting and taperturning.

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Admit between centres ..	17ft. 3in.
Swing over saddle	25in. dia.
Swing in gap	61in. dia. × 18½in.
Hollow spindle dia.	4½in
Spindle speeds (8)	8 to 160

NEW MITCHELL 14½IN. CENTRE × 16FT. GAP BED LATHE

Admit between centres ..	9ft. 9in.
Swing over saddle	21½in. dia.
Swing in gap	52in. dia. × 17in.
Hollow spindle dia.	4½in.
Spindle speeds (8)	8 to 250

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Automatic table feed cycle and rise and fall spindle carrier.

Table working surface ..	18½in. × 6½in.
Power longitudinal traverse	8in.
Vertical adjustment of spindle carrier	4½in.
Cross adjustment of spindle quill	1in.
No. of spindle speeds, with full set of gears	10
Range	75-1,100 r.p.m.

NEW G.S.P. 9FT. RADIAL DRILLING, TAPPING AND BORING MACHINE

With pump and loose box table.

Spindle	No. 6 Morse taper
Capacity in cast iron ..	4⁑⁄₃₂in.
Capacity in steel	3¹⁷⁄₃₂in.
Tapping capacity	3in.
Spindle feed	18½in.
Max. dis. spindle to baseplate	6ft. 3in.
Column dia.	23½in.
Traverse of saddle along arm	6ft. 8 in.
Spindle speeds	8-1,725 r.p.m
Working surface of baseplate	9ft. 1in. × 4ft. 7in.
H.P. of main motor ..	12
Weight approx.	11½ tons.

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One head carries vertically mounted segmental wheel: other is lighter, with swivel adjustment: rapid power traverse for raising and lowering: push button control: infinitely variable table speeds.

Approximate dimension

Overall size of table.. ..	9ft. 8in. × 2ft. 3in.
Speed of table	6ft. 6in. to 38ft. per min.
Max. grinding length ..	6ft. 6¾in.
Max. grinding width ..	2ft. 3½in.
Dia. of segment wheel ..	19¾in.
Weight	6½ tons
Humphrey magnetic chuck	6ft. × 1ft. 6in.

WANDERER MODEL 3IL 1000 MOTORISED UNIVERSAL LONG THREAD MILLING AND HOBBING MACHINE

For internal and external threads, helical and parallel splines, worms, etc.

Length of hob spindle travel	39½in.
Height of centres	3¾in.
Maximum swing over saddle	8in.
Maximum work dia. over bed	16½in.
Dia. of hollow spindle ..	3⁹⁄₁₆in.
Pitch of leadscrew	½in.
Number of cutter spindle revs.	5
Range of cutter rev. ..	55, 80, 118, 170, 250 r.p.m.
No. of feeds per rev. ..	32

OMEROD 26IN. STROKE HEAVY DUTY HIGH SPEED SLOTTING MACHINE

With power feeds and rapid traverses to table in all directions.

Max. dia. admitted	7ft. 2in.
Max. height admitted ..	3ft. 6in.
Working surface of table ..	50in. × 50in.
Longitudinal traverse of table	3ft. 9in.
Cross traverse of table ..	3ft. 4in.

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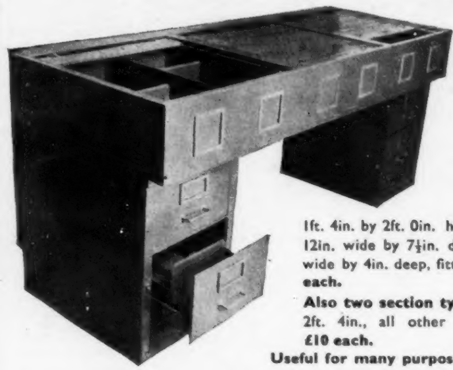

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